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THE AIRCRAFT ENGINEER

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THE STEREOMAT

A New Technical Aid to Anti-Aircraft Artillery Training

By MAJOR BRÄNDLI (SWITZERLAND)

ANTI-AIRCRAFT artillery, both on land and sea, is growing in efficiency from day to day. Experience has shown that, if properly organised, it can be an extremely effective weapon of defence for ships as well as for prospective land targets.

During the Great War A.-A. artillery was as yet in its infancy; in the past twenty years, however, great advances have been achieved in the construction of A.-A. guns of all calibres, and, more particularly, in their sighting devices.

In effect, there was but one problem awaiting solution at the outbreak of the present war, viz., the elaboration of a method whereby A.-A. gun-crews could be thoroughly trained in their duties with the necessary rapidity. It was more than the mere question of providing highly efficient technical equipment, such as telemeters, fire-control units, detectors, searchlights, etc. The gun-crews had to be taught to handle them skilfully in practice as well as in theory—during actual gunnery exercises.

The main responsibility for this task devolved, of course, upon the battery commander directing operations from the central fire-control unit. The great importance of having thoroughly trained A.-A. gun-crews lies in the fact that firing at aircraft demands the utmost mental mobility and an expert knowledge of the technical equipment, since it is essential that every advantage be taken of the element of surprise, for obviously A.-A. gunning is likely to be really successful only if hits are scored in the very first bursts of fire. Field artillery may have time to try out the range and straddle its target before settling down to serious operations, but the A.-A. gunner has no leisure for experiments. To be efficient he has to perform the extremely difficult task of calculating the firing elements, in advance, continuously, and with sufficient accuracy to place the very first shots right on to his target.

Mechanical Assistance

Even with the very best equipment, it is physically impossible for a man to achieve this feat without systematic and careful training.

One of the greatest difficulties to be overcome when training A.-A. gunners is that of maintaining sufficiently accurate and uninterrupted control and supervision of both guns and auxiliary equipment during firing operations. In the case of field artillery crews it is easy enough, but in A.-A. work sometimes quite impossible.

Other problems are encountered, even when shooting with live shells at flying targets

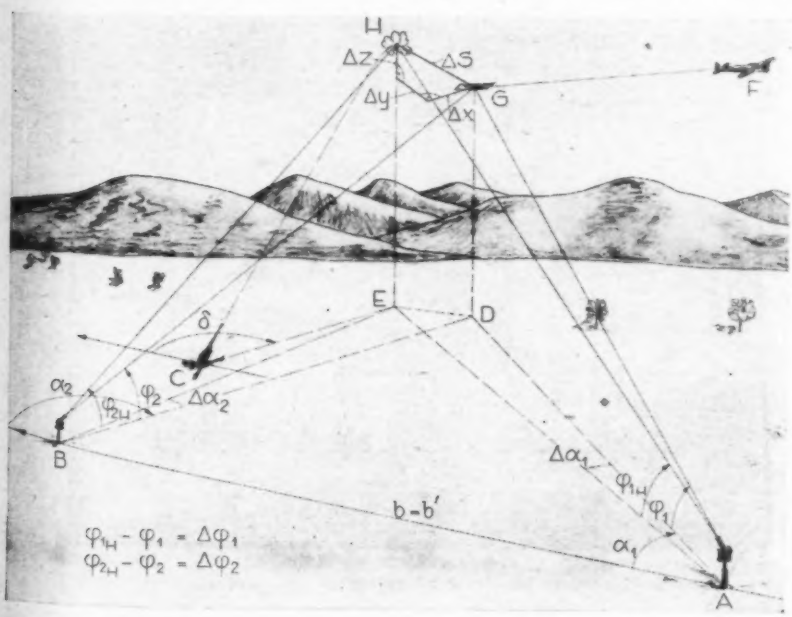
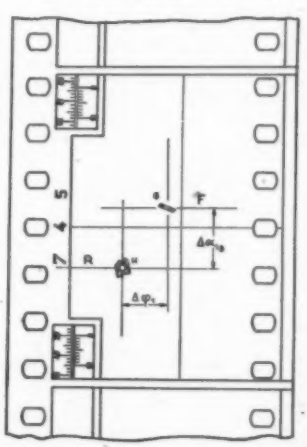


Fig. 1 (left) and Fig. 2 (below).



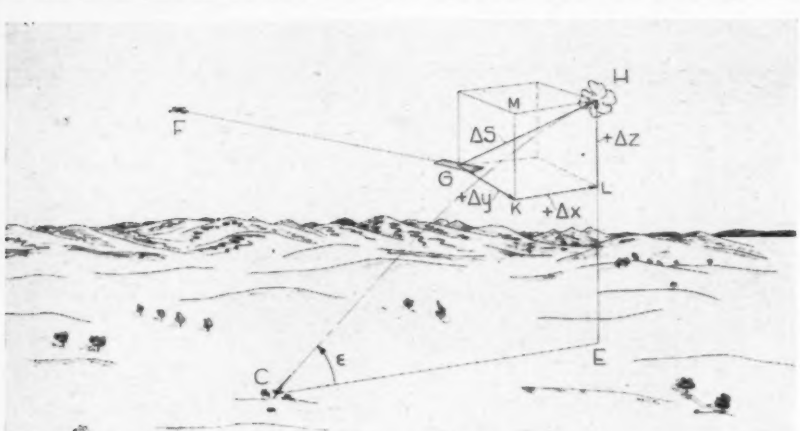


Fig. 3

(sleeve targets, remote control planes, etc.), owing to the fact that observation posts, such as are employed to direct field-artillery fire, are here of little practical assistance, since, unlike the landscape, the sky presents no fixed points from which to take bearings when range-finding. With the usual observation instruments, therefore, even approximate estimates or measurements are impracticable. Moreover, experience has shown that caution is to be observed in judging the quality of shooting even from " hits " on a sleeve target ; it is essential to ascertain the exact positions of the shots. This can only be done with special technical equipment.

Since the only criterion by which to judge whether an A.-A. battery has shot well or badly is given in practice with towed targets or remotely controlled aircraft, an objective check-up on actual results obviously becomes essential. The principles applicable in this connection are much the same for A.-A. as for the usual field artillery practice. Above all, the relative positions of the shots to the target must be ascertained. It is only when the points at which the time-fused shells have burst are known in relation to the target, that the effectiveness of the fire can be ascertained.

A.-A. artillery, however, is exposed to various important influences causing disturbance and error, so that the determination of the exact spot at which each individual shell bursts is here of greater practical value than in the case of field artillery in that it enables the cause of the error to be traced and remedied. This latter point is the most vital factor in the evaluation and discussion of practice results.

It is for this reason that special measuring instruments have been introduced on every A.-A. practice ground. Their object is to locate the point of the shell-burst in relation to the target.

Fig. 1 shows a typical instance of these instruments in action. The aeroplane F is towing a sleeve target G which is under fire from the gun C. Two film-theodolites are

$$\Delta x = \frac{b'\left\{\left[\sin\alpha_2\cdot\cos(\alpha_2-\alpha_1)+\Delta\alpha_{1_B}\cdot\sin\alpha_2\cdot\frac{\cos\varphi_1}{\cos\varphi_2}\cdot\Delta\alpha_{2_B}\right]\cdot\cos(\alpha_2-\delta')-\left[\sin\alpha_2\cdot\sin(\alpha_2-\alpha_1)-\Delta\alpha_{1_B}\right]\cdot\sin(\alpha_2-\delta')\right\}}{\cos\varphi_1\cdot\sin^2(\alpha_2-\alpha_1)}$$

$$\Delta y = \frac{b'\left\{\left[\sin\alpha_2\cdot\cos(\alpha_2-\alpha_1)+\Delta\alpha_{1_B}\cdot\sin\alpha_2\cdot\frac{\cos\varphi_1}{\cos\varphi_2}\cdot\Delta\alpha_{2_B}\right]\cdot\sin(\alpha_2-\delta')+\left[\sin\alpha_2\cdot\sin(\alpha_2-\alpha_1)+\Delta\alpha_{1_B}\right]\cdot\cos(\alpha_2-\delta')\right\}}{\cos\varphi_1\cdot\sin^2(\alpha_2-\alpha_1)}$$

$$\Delta z = \frac{b'\left\{\left[\sin\alpha_2\cdot\cos(\alpha_2-\alpha_1)+\Delta\alpha_{1_B}\cdot\sin\alpha_2\cdot\frac{\cos\varphi_1}{\cos\varphi_2}\cdot\Delta\alpha_{2_B}\right]\cdot\sin\varphi_1+\sin\alpha_2\cdot\sin(\alpha_2-\alpha_1)\cdot\Delta\varphi_1\right\}}{\cos^2\varphi_1\cdot\sin^2(\alpha_2-\alpha_1)}$$

$$\Delta S = \sqrt{\Delta x^2+\Delta y^2+\Delta z^2}$$

Fig. 4.

placed at the points A and B respectively, separated by a horizontal base-length b'. The target G is kept continuously in view and filmed by the theodolites, so that if a shell-burst H appears in the vicinity of the target,

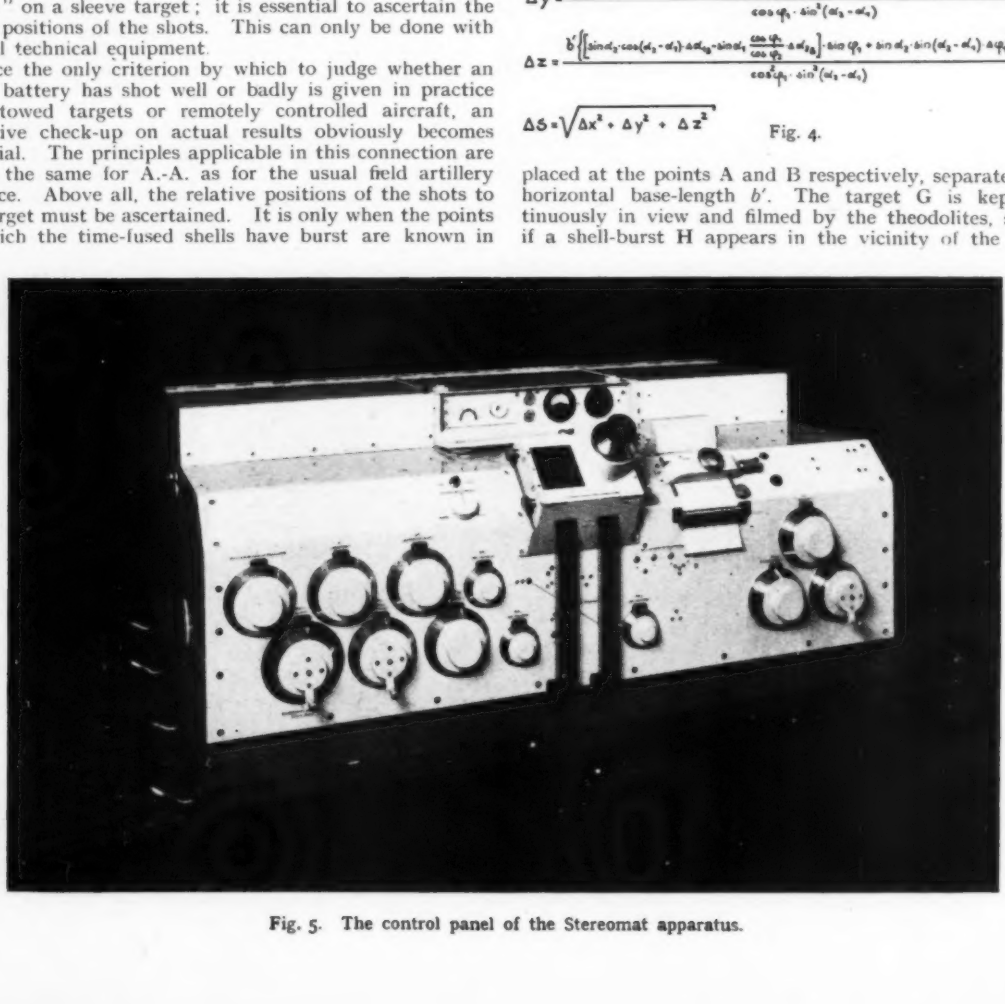


Fig. 5. The control panel of the Stereomat apparatus.

it is photographed simultaneously by both theodolites.

Fig. 2 shows a specimen of a theodolite photo thus obtained. In two corners of the picture there are scales characterising the bearing angles (α_1, α_2 and ψ_1, ψ_2 in Fig. 1) of the theodolite at the moment the picture was taken. The picture also bears a photographed registration number (745 in Fig. 2); its chronological counterpart, taken with the second theodolite, bears the same number. From these two film pictures it is now necessary to calculate the position of the shell-burst H relatively to the target G.

In Fig. 1 the distance from the shell-burst H to the target G—the effective firing error—is denoted by ΔS. It is by no means sufficient, however, to calculate ΔS alone; it is obvious that, if an analysis is to have any practical value at all, the components of the firing error ΔS, viz. Δx, Δy and Δz, must be determined in relation to the trajectory plane CEH.

Fig. 3 illustrates similar conditions in a somewhat different situation; it also defines the components of ΔS in a practical form. It will be noted that all the components are positive when the shell-burst H is behind, to the right and above the target, i.e., when the shot was too long, too high and to the right.

Mathematical treatment of the above problem—the calculation of the firing error ΔS and its components Δx, Δy and Δz—present us with the formulæ shown in Fig. 4. The amount of time and labour expended in obtaining the firing error and its components from these formulæ for a lengthy series of shots is, of course, very considerable, apart from the danger of errors in calculation. It therefore became urgently necessary to provide some practical method of facilitating and curtailing the work, besides ensuring absolute accuracy.

This task has now been accomplished by a Swiss firm, Contraves Ltd., Zürich, who have succeeded in evolving an apparatus which, quite automatically, works out the firing error and its components from the formulæ given in Fig. 4. The new apparatus is called the Stereomat, and is shown in the photograph (Fig. 5).

The Stereomat calculates and registers the results desired in the space of a few seconds. It is entirely automatic in its functioning, the only manual operations being the adjustment of a number of knobs to the features of the film pictures. The remaining operations are performed electrically, and the results obtained are sufficiently accurate for all practical purposes. The instrument can cope with any and every positional configuration of the gun and theodolites, irrespective of the slope or formation of the terrain.

Thus it is possible to obtain the evaluation results required for checking-up on firing practice within a few minutes after the developed and dried films have come to hand. The calculating process is simplicity itself and comprises the following operations, which can be carried out by one chief operator and two assistants :—

(*a*) Adjustment of a knob to insert the horizontal distance b' between the base points; similar adjustments for the base azimuth.

(*b*) Insertion of the two film strips in the optical slide and adjustment of a hair-cross F to cover target G and hair-cross R to cover shell-burst H (compare Fig. 2).

(*c*) Reading off of angles α_1 and α_2, and ψ_1 and ψ_2 (see Fig. 2), and insertion of these values via the respective graduated knobs.

(*d*) Release of the electrical calculator by pressure on a button.

The result is registered on a recording slip as sketched in Fig. 6. It will be noted that the linear division of the slip makes allowance for the degree of accuracy required. A more distinct impression is obtainable by drawing lines to connect the recorded points. The figures 50, 100, 200, 300 printed on the slip denote the magnitudes in metres of the respective deviations from the zero line indicating the position of the target. Bearing Fig. 3 in mind, we can, for instance, read off the following deviations for shot No. 2 :—

$\Delta x = -70$ m. (short)
$\Delta y = +13$ m. (right)
$\Delta z = -58$ m. (low)
$\Delta S = +91$ m.

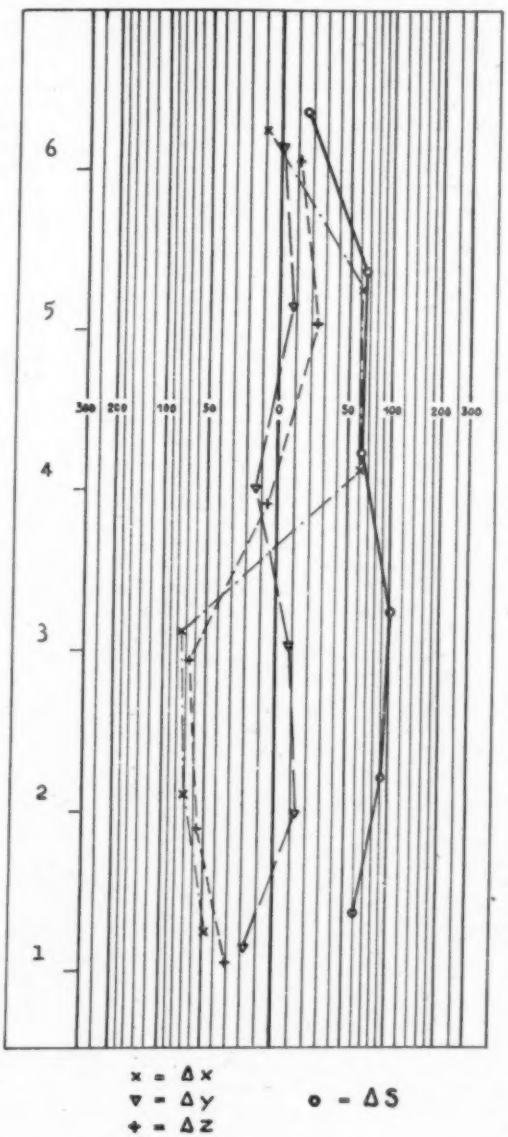


Fig. 6.

In Fig. 6 we see that the side aiming (Δy) was very good for all shots. The first three rounds were probably timed too short owing to inaccurate telemeter readings. This must have been corrected after the third round, for we observe that there was a distinct improvement up to the sixth shot.

The advantages of Stereomat evaluation may be summed up as follows: Being entirely automatic, the apparatus can deliver up to 75 or 80 single evaluations an hour. With the registration slip thus obtained it therefore becomes possible to hold a thorough and objective discussion on the firing practice shortly after it has taken place. This is particularly important in connection with A.-A. practice gunning; it is not so necessary when the target is on the ground, since here it is possible to keep the target and shell-burst positions in memory, and even subsequently to examine them. But when firing at aircraft there is no fixed background, which makes it very difficult to recall the events of a fire practice afterwards. To discuss it with the gun-crew is only worth while when all the men concerned can clearly remember the details. For this reason alone the Stereomat has enormous advantages, apart from the fact that it

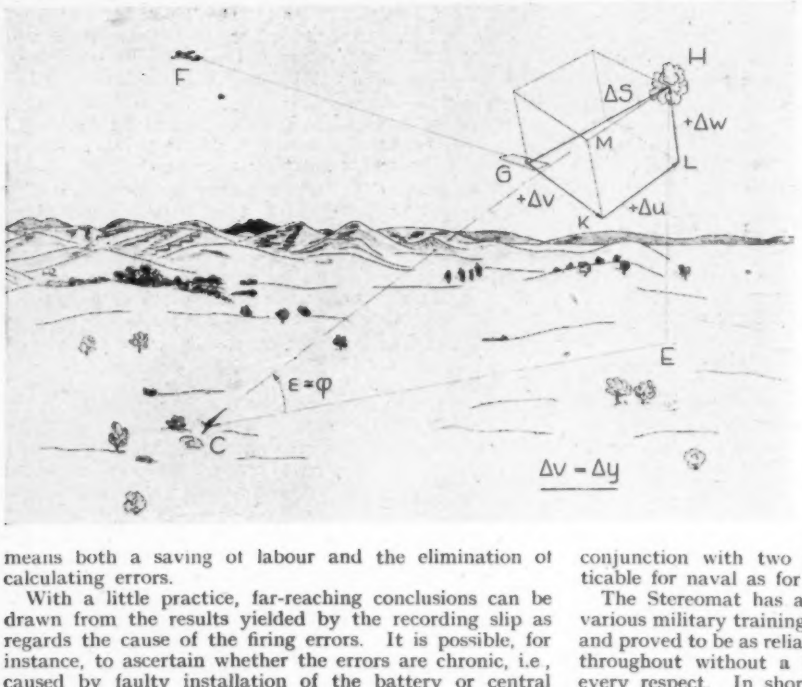


Fig. 7.

means both a saving of labour and the elimination of calculating errors.

With a little practice, far-reaching conclusions can be drawn from the results yielded by the recording slip as regards the cause of the firing errors. It is possible, for instance, to ascertain whether the errors are chronic, i.e., caused by faulty installation of the battery or central control equipment, faulty adjustment of the telemeter, etc., or whether it is a question of bad mistakes in telemetering or other operations. Moreover, the registration slip shows distinctly the effect of corrections made during actual firing.

Informative Study

Close study of a set of registration slips covering numerous practices yields many valuable hints as to the most effective firing tactics to be employed. The results furnished by the Stereomat so quickly and easily are of the utmost importance in the training of A.-A. gun-crews.

Furthermore, the performance of the Stereomat does not end with the calculation of the rectangular components Δx, Δy and Δz, of the firing error ΔS. With the same instrument it is possible to analyse the components in relation to the sighting ray from theodolite to target, as shown in Fig. 7. Since, in A.-A. work, the "operative" portion of the trajectory is usually, for practical purposes, an ascendant straight line, the aforementioned analysis amounts in practice to an analysis of the firing error in the line of trajectory and vertically to it. Now the Δy components remain as before, while a transformation takes place as regards the Δx and Δz components, e.g., in relation to the angle ψ_2. It is thereby assumed, however, that the gun C is placed in the immediate vicinity of theodolite B—a condition which, in practice, will not hamper normal operations.

Another important feature of the Stereomat is its usefulness in naval work. From the formulæ in Fig. 4 it will be seen that the values Δx, Δy, Δz and ΔS are appreciably altered when the differential magnitudes $\Delta\alpha_{1B}$ and $\Delta\alpha_{2B}$ and $\Delta\psi_1$ change.

Between the magnitudes $\Delta\alpha_{2_1}$ (see also Fig. 2) and $\Delta\alpha_1$ there exists the relation

$$\Delta\alpha_1 = \Delta\alpha_{1B} \frac{1}{\cos\psi_1}$$

This also applies analogously to $\Delta\alpha_2$. But Δx, Δy and Δz are more or less insensitive to minor alterations of the base-length b' and of the angles α_1, α_2, ψ_1, ψ_2 and δ. Thus it is also possible to make good use of survey instruments in naval work.

Fig. 8 shows one instance of their application. The two ships A and B are assumed to be at anchor, while vessel C, which is firing, may be moving in any direction. Minor movements of A and B around any mean position have no appreciable effect on the differences Δx, Δy, Δz and ΔS. The use of the Stereomat in conjunction with two theodolites is thus just as practicable for naval as for land A.-A. work.

The Stereomat has already been thoroughly tested on various military training grounds by the troops themselves, and proved to be as reliable as it is practical. It functioned throughout without a hitch and fulfilled its mission in every respect. In short, the end for which it was constructed has been fully realised in practice.

A means of control such as that provided by the Stereomat in conjunction with two theodolites is not merely a useful aid to training troops in peacetime; its importance is just as great in wartime. During the war in Spain, for example, it was noticed that some A.-A. batteries attained far better results than others of the same category. Faulty team work or faulty material is bound to reduce the efficiency of a battery enormously; this is particularly the case with A.-A. gunning, where it is absolutely essential that technical insufficiencies be remedied and any gaps left in the training of the gun crews filled in. The most rational manner of improving the work of inefficient batteries is to photograph their results with film-theodolites and evaluate them in the Stereomat. It can then be seen whether the fault lies in the quality or the handling of the technical equipment; technical defects can be corrected, inefficient operators or commanders weeded out, and the battery as a whole tuned up to maximum efficiency.

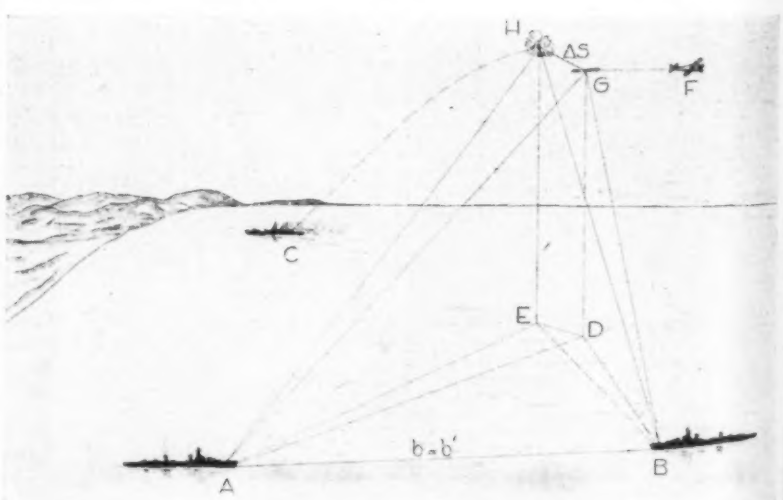


Fig. 8.

HERE and THERE

Congratulations!

HIS many friends in this country and in the United States will be glad to learn that on January 17 Mr. F. Sigrist's wife Beatrice presented him with a daughter. Both are doing well at their home at Warfield Hall, near Bracknell, Berks. *Flight* hastens to add its sincere congratulations to the many which Mrs. Sigrist and "Uncle Fred," will have already received.

Italian Record Attempt Fails

A SAVOIA MARCHETTI 75, commanded by Col. Tondi, of the Royal Italian Air Force, started from Rome on January 14 on an attempt to beat the world's long-distance record held by two Vickers Wellesleys. The Italians encountered a severe storm over the South Atlantic, and strong head winds delayed their progress to such an extent that they had to land on an island off the Brazilian coast. They had then covered a distance of 4,375 miles in a flying time of 32 hours 25 minutes, thus falling far short of the British record, which was of 7,162 miles. The Regia Aeronautica will not be defeated by this setback, and we wish Col. Tondi and his crew better luck next time.

Resumption of R.Ae.S. Lectures

ARRANGEMENTS are being made by the Royal Aeronautical Society to resume part of the lecture programme which was postponed on the outbreak of war. The giving of these lectures depends upon the war situation and the censorship, among other things, and what arrangements are being made can only be made with these two points in view.

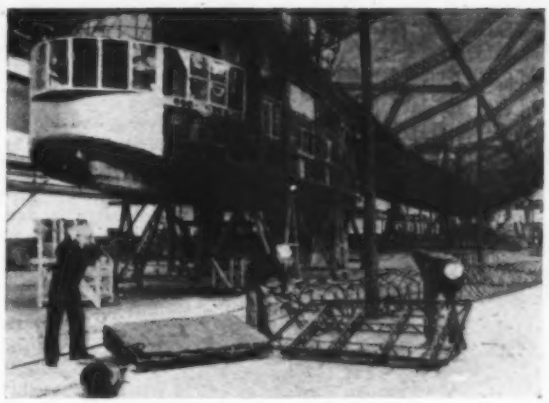
It is hoped to arrange definitely for four or five lectures. The first one, on "Aircraft Production," will be given by Mr. H. J. Pollard, F.R.Ae.S., on Tuesday, March 12, 1940, in the Institution of Electrical Engineers at 6 p.m.

Sir Alan Cobham and Mr. Marcus Langley have provisionally agreed to give a joint lecture on "Flight Refuelling in the Air," Mr. A. A. Hall on "Recent Theoretical and Experimental work on Turbulence," and Wing Commander T. R. Cave-Brown-Cave on "Noise and Nuisance in Aircraft," at dates to be fixed. The Wilbur Wright lecture will be delivered at the end of May.

The Coventry Branch of the R.Ae.S.

LECTURE programme cancelled at the beginning of war. In response to many requests from members, an attempt is being made to resume meetings, and the following lecture programme has been drawn up:—

Tuesday, January 30.—"Plastics," by Dr. N. A. de Bruyne, Director of Aero Research, Ltd.



FOR THE SCRAP HEAP: The U.S. airship Los Angeles being dismantled and broken up at Lakehurst.

Friday, February 16.—R.A.F. Instructional Films on "Meteorology, Fog, and Ice Formation."

Tuesday, March 12.—"Optical Methods of Measurement."

Tuesday, April 2.—Subject to be announced later.

Meetings are held at the Geisha Café, Hertford Street, Coventry, at 7.15 p.m. The Chairman of the Branch is Air Marshal Sir John Higgins, now abroad. Vice-Chairman (now Acting Chairman) is Mr. E. D. Keen, A.F.R.Ae.S. Acting Hon. Secretary is Mr. J. A. Beardsall, Student R.Ae.S.

Scholarship Scheme.—Valid for 2 years. Tenable at Coventry Technical College. Instituted in 1939. First award to Reginald Dennis Lowe, apprentice at Armstrong Whitworth Aircraft, Ltd.

Patriotic Dunlop Workers

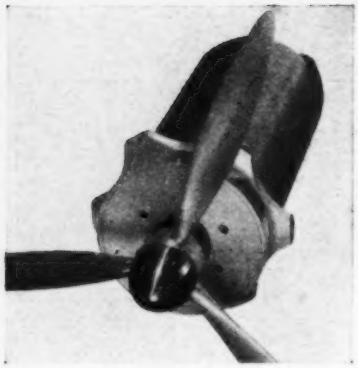
DUNLOP employees have given up their holiday savings for National Savings Certificates. At Fort Dunlop alone they saved nearly £10,000 for the last holiday of peacetime, and a gift of £150 from the company was balloted for at the final share-out last July.

Now the sixpenny holiday stamps bearing the head of John Boyd Dunlop have been surrendered for sixpenny National Savings stamps. The stamps, which are on sale throughout the works and offices, will be stuck in a special savings stamp book to be exchanged, when it holds thirty, for a National Savings Certificate.

The money already subscribed to the holiday savings scheme at Fort Dunlop has been handed back to the employees there who bought National Savings Certificates with it.

STRANDED IN THE ICE: Crews of Dutch vessels in the Zuider Zee form letters asking for help from aircraft.

THE INDUSTRY



Electric motor for wind tunnel models by Aviation Corporates Ltd.

Timken Appointment

MR. R. TURNER HOOD who has for some while held the post of chief Scottish sales representative for British Timken, Ltd., the roller and ball-bearing concern, has now been appointed chief of the mechanical engineering department of the company. Mr. Hood started his career by serving his apprenticeship with Barr and Stroud, Ltd., the Glasgow manufacturers of marine and aeronautical precision instruments.

Luxor Goggles

FOR those who want real eye comfort whilst flying, E. B. Meyrowitz, Ltd., the Old Bond Street opticians, have made special provision in their model No. 6 Luxor.

In addition to all the usual good features associated with Luxor goggles No. 6 is fitted with hand ground, laminated and prism corrected lenses. These lenses, not being of synthetic material, will stand up to severe usage and, in addition, may be had in various tints which are useful when flying in brilliant sunshine and of some advantage in fog. No. 1a, Old Bond Street, W.1, is the address for further details.

Tunnel Model Motors

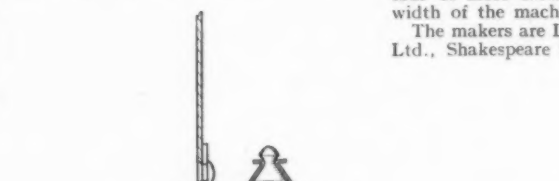
IN his Wright Brothers lecture, on the influence of running airscrews on aeroplane characteristics, Dr. Clark B. Millikan drew attention to the recent spectacular increase in wing loading with the accompanying decrease in power loading. At the same time he remarked on the increased percentage of the wing area affected by the slip stream owing to the four-engined installation becoming more widely used.

His point was the difference between engine-on and engine-off flying. He went on to explain the apparatus used at the Guggenheim Aeronautical Laboratory to study this effect in the wind tunnels. He spoke of small electric motors used on models of about 7ft. span capable of running up to 18,000 r.p.m. Aviation Corporates, Ltd., inform us they are agents in this country for the manufacturers who are specialists in producing this type of electric motor to almost any specification.

Obviously almost every "engine" is a "one off" product but among others they have already produced a 4-6 h.p. model running at 15,000-18,000 r.p.m. for an overall size of 6⅛in. by 3¾in. for Boeing and for Lockheeds, a 30-40 h.p. model running at 10,800 r.p.m. which is designed to duplicate an "in line" type of engine. This motor measures only 4¾in. by 18in. Aviation Corporates, Ltd., whose address is 50, Pall Mall, London, S.W.1, will furnish any further particulars that may be required of these specialised model motors.

Macrome Unlimited

IN the midst of a world of cancelled or reduced advertising and dismissed travellers we commend the policy of Macrome, Ltd., of Hay Mills, Birmingham, whose slogan "The Toughest Tools in the World" has been amply proved by many internationally known companies. They are showing toughness of another kind by their policy of increased advertising, by which their advertising department has been extended and the staff increased.



An example of the well-known Oddie fastener.

Hangar-Tarmac Sweeper

ORIGINALLY developed for municipal use, the Lewin hand-controlled power-driven sweepers are being found of increasing use in aeroplane factories, hangars and aerodromes. A model specially modified to comply with Air Ministry requirements is now in production.

The Lewin sweeper-collector machine is built in widths of from 3ft. to 5ft. and is driven by a Villiers fan-cooled two-stroke engine of 249 c.c., transmission to the axle being by chain through a large countershaft plate clutch. The rotating brush is set at a slight inclination to the line of travel and is accordingly shaft driven through angle gears and a universal shaft from the axle. To facilitate sweeping close up to walls or kerbs the brush overhangs the body of the machine some 4in. on the near-side. A collector-box of 3½ cu. ft. capacity is arranged in front of the brush and this can be tipped by a lever from the control position.

Clutch and throttle are operated from the near-side handle grip and for use in aircraft establishments the clutch is so arranged that the machine will stop if for any reason the operator releases his hold. A sweeping speed of 2 to 3½ m.p.h. is within the control of the operator and 5,280 to 8,800 sq. yds. can be covered in the hour. An idler wheel in front ensures constant brush pressure for which there is also an independent setting. When necessary a water-sprinkling apparatus can be installed. The brushes fit interchangably on to a square shaft and can be rapidly replaced or rearranged to compensate for uneven wear; each brush assembly consists of four or more sections according to the width of the machine.

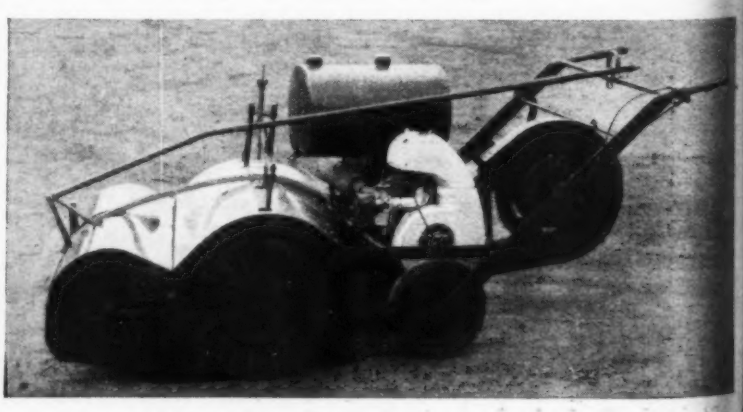
The makers are Lewin Road Sweepers, Ltd., Shakespeare St., Southport.

Oddie Fastener

DESIGN departments are referred to a booklet, which is being issued by Oddie, Bradbury and Cull, Ltd., the makers of the Oddie fastener, in which different models and typical applications are illustrated and described, complete with installation diagrams.

The Oddie fastener is too well known to need a detailed description, but the advantages are that it is simple (only three parts), positive (load tends to lock the fastener), has a resilient mounting (to eliminate chattering), and is watertight.

The booklet is called "The Oddie Fastener," and may be had from Oddie, Bradbury and Cull, Ltd., The Airport, Southampton.



Latest model Lewin sweeper-collector for aerodrome service.

FLIGHT

and The AIRCRAFT ENGINEER

First Aeronautical Weekly in the World : Founded 1909

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No. 1623. Vol. XXXVII. FEBRUARY 1, 1940. Thursdays, Price 6d.

The Outlook

Promotion and Seniority

DESPITE occasional glaring instances of vicious red tape, the Air Ministry on the whole is not composed of such heartlessly inefficient bureaucrats as junior officers and rank-and-file are sometimes disposed to imagine. Where it certainly does err is in not always making its meaning and intention plain, and for that its excuse may be that it presumes, and feels obliged to presume, that every Pilot Officer knows by heart the King's Regulations and Air Council Instructions, Air Ministry Orders, and all other official publications. It is a lucky station at which all the clerks in the adjutant's office have all these matters at their finger tips.

Some consternation was caused lately by a ruling that seniority in the Auxiliary Air Force and the Volunteer Reserve should only date from the outbreak of war. Officers who had served for some years in these branches of the Force were at first naturally somewhat aghast at the idea that they would lose the credit for their very meritorious efforts over considerable periods in peacetime. Enquiries have shown, however, that that will not happen. On the outbreak of war the officers of the regular R.A.F. and those of the two non-regular bodies were merged into one list. Obviously it was only fair to the regulars, with their greater experience and higher training, that, rank for rank, the non-regulars should go on to that list at the bottom. Senior Pilot Officers of the A.A.F., for example, would be graded below junior Pilot Officers of the R.A.F. so long as they all remained Pilot Officers. But promotion to Flying Officer and to Flight Lieutenant takes place automatically after fixed times, provided an officer is recommended by his C.O., and the previous service of a non-regular officer does count towards promotion. Thus a Pilot Officer of the A.A.F. or V.R. General Duties branch, who had done seventeen months' service by Sept. 3, 1939, was junior to all regular Pilot Officers, but by Oct. 3 he was due for promotion to Flying Officer; and likewise a Flying Officer with twenty-three months' service on the outbreak of war became eligible for promotion to Flight Lieutenant one month later. In each case the step in rank would take him over the heads of a number of regular officers.

Unfortunately these facts are not realised by everybody, and station adjutants may overlook some things in time of war. We should therefore advise non-regular officers who have served long enough to qualify for promotion to make polite enquiries from their adjutant as to whether their names have been duly submitted to the Air Ministry.

Incidentally, during the war the time limits for promotion are to be one year from Pilot Officer to Flying Officer and one year from Flying Officer to Flight Lieutenant in all except the Administrative and Special branches of the V.R., where promotion is by selection board. Promotion to ranks above Flight Lieutenant is also by selection board in all branches of the Service.

And Flying Instructors

WHILE on the subject of Air Ministry arrangements, we would revert to the case of instructors at Elementary and Reserve Flying Schools, which has lately been much discussed. When those schools were started the Air Ministry decided, reasonably as most people will agree, that the instructors employed by the firms must belong to the Reserve of Air Force Officers. This created an opening for short-service officers who had completed their time with the squadrons and had to find jobs. As a concession, however, it was subsequently agreed that the firms who ran the schools might employ as instructors men who had never been in the R.A.F. provided that those men joined the Volunteer Reserve, which of course they had to do in the rank of sergeant pilot. It was agreed that in the event of war the flying instructors at these schools should not be called up unless they were urgently needed.

Then came the war, and for various reasons the instructors who were in the R.A.F.O. found it unpleasant and actually inconvenient to be in mufti, and they wanted to be called up and put into uniform, though

remaining at their jobs. The V.R. sergeants naturally did not want the same thing, but the R.A.F.O. men were in a considerable majority, and finally the Air Ministry acceded to their wishes. All accordingly received the pay of their rank, and a married sergeant pilot gets, with allowances, some £350 a year, or more if he has children. This may have meant a considerable loss of income in some cases, but that also happens when, say, a business man in a good appointment gets called up as a Captain of a Territorial battalion. It is, in fact, a common result of war and conscription, or even of war without conscription, as many men who fought in 1915 know well.

As we remarked in a previous article on this subject, there is no reason why a flying instructor who teaches officers to fly should not be a sergeant, as that happens in peace time at every F.T.S. in the Service, and even at the Central Flying School.

However, the Air Ministry is not unwilling to consider cases which may seem hard, and we understand that a number of the R.A.F.O. instructors have already been promoted, while not a few of the instructors who are sergeant pilots in the V.R. will before long receive commissions.

After all, as a Scottish officer posted to a base during the last war remarked, "It may be very dull at the base, but at least there's no one there who is trying to take your life."

The Plight of Civil Aviation

SINCE the early days of the war *Flight* has, from time to time, pointed out the folly of letting civil aviation, and more particularly commercial aviation, die for lack of support. The position has not become better since last we referred to the subject. In fact, it is growing steadily worse.

Something will have to be done, and that very soon —or it will be too late. This is a good time to point out that it seems to have been forgotten that the Brown Committee (its official title was, if we remember rightly, the Civil Aviation Planning Committee) recommended, not very long before the outbreak of war, that a Civil Aviation Development Committee should be formed. What, we wonder, has become of that committee? It is more urgently needed than ever.

We do suggest that this committee should be formed without delay, so that it could carry out its investigations (which are bound to take considerable time) and in due course make its recommendations to Sir Kingsley Wood. We think that might be a better policy than to take civil aviation away from the Air Ministry, a step which many astute observers recommend. If civil aviation was hampered during peacetime by being under military control, or at least placed secondary to service interests, an event better case can be made out during the war.

LET US NOT FORGET THE NAVIGATORS: It is natural that our gallant pilots should receive praise for the excellent work they are doing, but the navigators of the aircraft of the Coastal Command have the task of getting their machines from the base to distant objectives and back again in all sorts of weather. Here is one of them at work at his chart table in a Short Sunderland flying boat.

WAR in the AIR

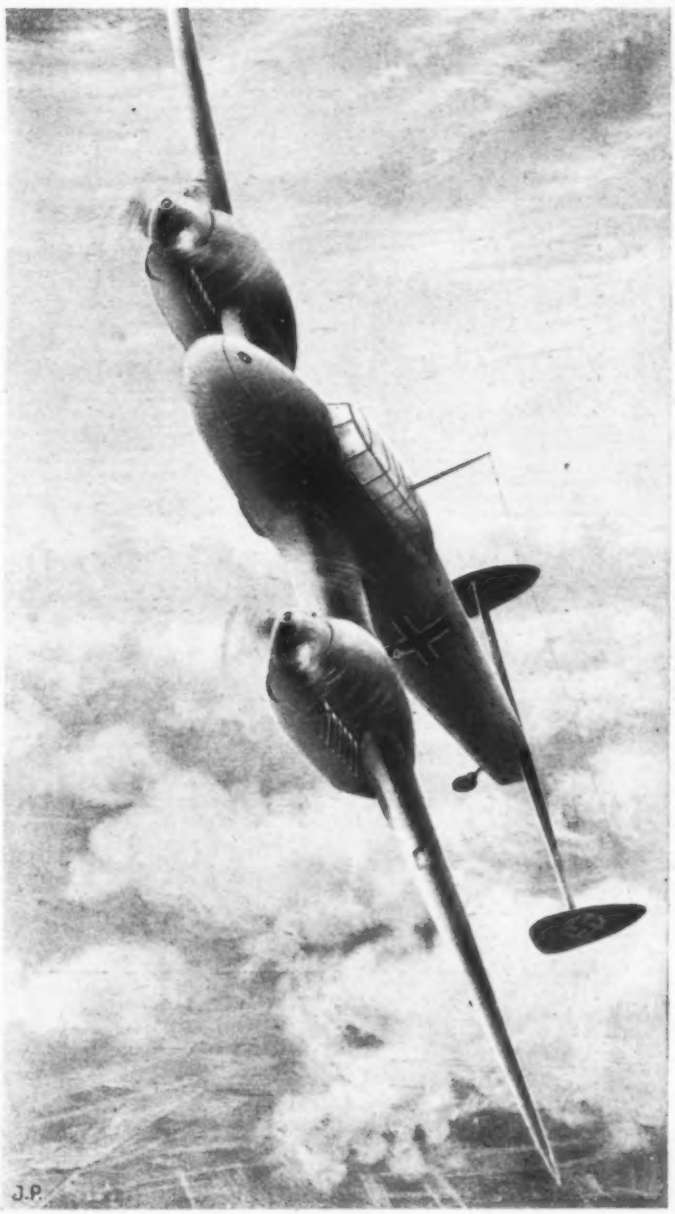
Winter and Rough Weather—North Sea Activity—On the Western Front—Balloons at Sea

THE intense cold which has spread all over Europe has curtailed flying to a great extent, though the patrol aircraft of the Coastal Command have defied the weather whenever it has been in any way possible to get into the air, and have scoured the seas in all directions round our coasts. Likewise the Bomber Command has despatched its long-range machines in sweeps and Security Patrols over the North Sea and kept a watch on the seaplane bases in the German islands. Every now and again the fading away of the broadcasts from the Hamburg station lets listeners know that the British bombers are in the neighbourhood, and this intelligence reaches neutrals and enemies as well as Allied listeners. All can draw their own conclusions, and it is easy to imagine that German subjects do not look forward to the day (if it should ever come) when Hitler may give the order for a great air offensive, and so let loose the bombs which have hitherto spared German soil.

Over the North Sea

OUR airmen report that movements of German ships in the North Sea have been few and far between of late. However, on the morning of January 20 some machines of the Coastal Command sighted four enemy patrol vessels, which at once opened fire on them. The primary duties of Coastal machines are to see and report, but their crews never refuse combat, and on this occasion they showed exactly how much they thought of the fire of the ships by dropping bombs at them. These were seen to fall very close to the ships, and our aircraft then returned without any casualties or damage.

German aircraft for some time were more inclined to stay in their hangars than to face the risks of icing up, and after the shooting down of a Heinkel off the Firth of Forth on January 13 there was quite a lull in German approaches to our shores. This lasted for nearly a week, and not until January 19 did we have another visitor. This one appeared off the coast in the neighbourhood of Aberdeen, and (as was reported in our last issue) was driven off undamaged. Then came another lull until January 24, when the Germans seemed to think they really must do something to show that they were still alive. It seems now to be the German rule that when they cannot think of anything really useful to do they fly to Shetland and drop some bombs there. That enables them to say that they do not merely take photographs of towns on the East Coast of Britain, but actually drop bombs on a British harbour and on British soil. Moreover, if they can achieve surprise in arriving there, which does not seem to be very difficult, they can drop their bombs and escape before the fighters, which are now stationed in the islands, are able to make contact with them.



Popularly termed a "destroyer" the German Messerschmitt Me 110 twin-engined multi-purpose machine has so far been chiefly employed for attacking formations of our bombers. Shell-guns fire through the hollow airscrew hubs and there is additional armament in the fuselage.

With a clear sky this would be hazardous, for the fighters certainly have the legs of any bombers which can make that distance; but when there are plenty of clouds to hide in, the risk is not great. So on this occasion the Germans aimed some bombs at a ship off the coast and, as usual, missed it. Then they came over the islands, but by that time our fighters were in the air, and one of the Germans had to unload his bombs hurriedly in the wilds, and climb for his life into the clouds. The whole affair from warning to "raiders passed" took half an hour.

WAR IN THE AIR (CONTINUED)

"Lightermen" barrage balloons flown from barges are used to restrain mine-laying seaplanes.

On Wednesday, 24th, and Thursday, 25th, there were false alarms off the East Coast and the Thames estuary respectively, caused in each case by friendly aircraft. A few rounds were fired by A.A. guns in the first case, but reports that guns came into action along the Thames on the 24th were inaccurate. Another mistake was made by the authorities in Holland, who stated officially that a British aircraft of the R.A.F. flew over Dutch territory on the afternoon of January 22, and was fired on by Dutch A.A. guns. The Air Ministry made full enquiries, and established the fact that the machine in question could not have been British. There is, however, no doubt that German aircraft have been violating Dutch neutrality fairly freely of late. They have been fired on, and Dutch fighters have gone up to intercept them.

Mass Attack on Shipping

THE Germans, however, showed surprising activity on Monday, January 29. Perhaps reports of the traffic delays in Great Britain, due to weather conditions, had led them to suppose that our defences might have become dormant. At any rate, raiders appeared at a considerable number of points between the Firth of Tay and the coast of Kent, and they attacked thirteen British vessels with bombs and sometimes with machine guns as well. Among these vessels were two lightships. Some bombs were also dropped in the sea off the Shetlands. No vessel reported serious damage, although a number of sailors were killed. At various places British fighters went up, and whenever a raider saw any of them it hurriedly took cover in the clouds.

In a recent issue we recorded the daring flights made by machines of the Bomber Command over Prague and Vienna. It is hard for people in Britain, many of them huddling over large fires in the attempt to keep out the bitter cold, to realise what the crews of these bombers have to endure on such long flights at great altitudes.

Heights of three, four and five miles above the earth are sometimes attained by these aircraft on flights of that description. Extreme cold and the rarified air at such high altitudes are the airman's two greatest dangers. On recent night flights over Germany temperatures as low as 52 degrees of frost have been encountered and ice has formed in layers on the cockpit floor inside the aircraft. For protection against such intense cold the airman relies almost solely upon warm clothing. Electrically heated flying clothing is no longer generally employed in the R.A.F. In the event of a failure of the electrical supply at high altitudes, the entire crew would immediately

A Dornier Do 215 reconnaissance machine (two Daimler Benz DB 601s) brought down behind the French lines. If the engines are of the direct-injection type, as is probable, they will form an interesting comparison with the Junkers Jumo 211A as described in *Flight* of January 18.

"British Movietonews" photograph

The R.A.F. crews who carried out the reconnaissance over Prague and Vienna.

be deprived of their sole protection against the cold.

As height increases, air pressure becomes less and the atmosphere progressively more rarified. To guard against risk of premature collapse it is the usual practice for oxygen inhalation to begin at 10,000ft., the rate of supply being steadily increased as the aircraft gains height. Each member of the crew wears an oxygen breathing mask covering his nose and mouth, and from the mask is suspended a length of flexible tubing which is plugged into the oxygen point nearby.

From an aircraft travelling 200 miles per hour at a height of 20,000ft. the bomb has to be released two miles and a half in advance of the target. Moreover, to ensure any degree of accuracy in the bombing, the aimer must begin to sight his target some three miles from the point at which he will release the bomb, a total of five miles and a half from the target itself. During such a run it is essential that the pilot should maintain a straight and level course, a fact of which the enemy's anti-aircraft gunners naturally take advantage. In such a situation the bomb-aimer can only strive to ignore the bursting smoke-puffs around him and find what comfort he can in the well-known maxim of the air "The higher the safer."

Australia's Effort

AIR MARSHAL SIR CHARLES BURNETT has now left to take up his new appointment as Chief of the Australian Air Staff. His predecessor, Air Vice-Marshal Williams, the senior officer of the Royal Australian Air Force, has been promoted to Air Marshal. He is now serving for a period with the R.A.F., and is Officer-in-charge of Administration on the staff of the Coastal Command. When he returns to Australia he may be appointed to take charge of Australia's part in the Empire Air Training Scheme. This will involve a five-fold increase in the aircraft and personnel in the Commonwealth, and the training of 26,000 pilots and air crews—all in addition to what Australia will send for training to Canada.

The Balloon Barrage

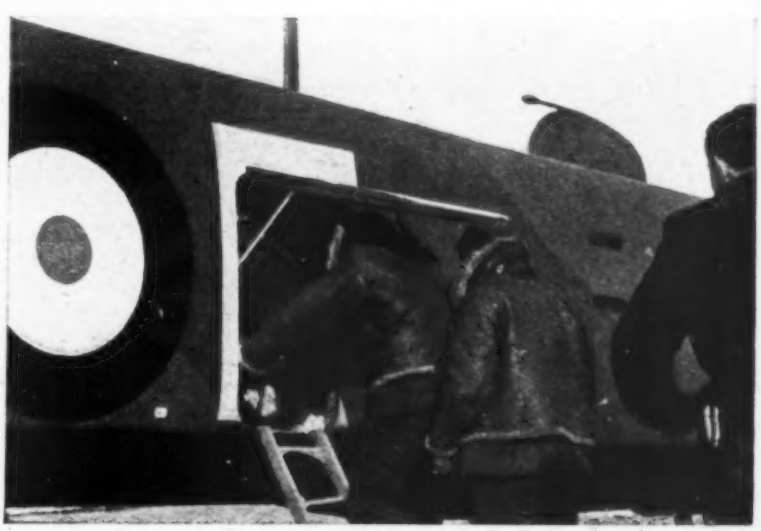
THE balloon barrage now extends over more than 700 miles of land and sea in and round Great Britain. Balloons flown from floating platforms are playing their part in preventing German seaplanes from laying mines in shallow waters and estuaries. Despite the intense cold, there have been more volunteers for work on the floating winches than could be accepted. On land, too, more balloon squadrons are constantly being raised, and the recruits are learning the delicate work of handling the balloons with gratifying speed.

Western Front

French Communiqué No. 244 of January 3 states:—

"BEFORE midday, two enemy machines had been forced down by our fighters."

This double success had been preceded by a series of numerous and varied aerial operations. French machines had made 107 flights this day. The good weather had



A "British Movietonews" photograph of a crew going aboard their Whitley V for the Vienna and Prague reconnaissance.

WAR IN THE AIR (CONTINUED)

Armed with one 20 mm. shell-gun and two Chatelleraut rifle-bore machine guns the Morane MS 406 single-seater fighter is a popular type in the French Air Force. Above are two views of activity on a French Morane aerodrome before a patrol.

favoured aviation and our pilots had rightly decided not to rest. Flights for observation, photography and reconnaissance were pushed far into enemy territory, and (so *Les Ailes* records) some as far as 200 or 250 miles.

One of these flights, escorted by fighters, encountered a patrol of Messerschmitts. Our machines immediately engaged them, but the German fighters broke off the engagement after the first bursts of fire and let the French aircraft pursue its mission.

A little later other French fighters forced down a Dornier Do 17; others did the same also to a Messerschmitt.

German aviation was equally active; observation machines made frequent flights over the lines and reconnaissances were pushed nearly up to the Parisian region.

British Machine Down in Belgium

THE same day an R.A.F. machine was forced down in Belgium. On a reconnaissance flight over Germany, he was met by a Messerschmitt patrol and encountered severe anti-aircraft fire. The machine having been severely damaged, the pilot was forced to seek refuge in Belgium. He crossed the frontier in the neighbourhood of Eupen and descended immediately, one of the members of the crew leaving the machine by parachute. There was not sufficient height for the parachute to open, and he, unfortunately, was killed. Immediately after the aeroplane hit a high-tension line; it took fire and struck the ground, the débris being scattered over a considerable distance. Although given up for lost, the two men remaining on board got out of this catastrophic descent with light burns, which did not endanger their lives.

The War in Finland

THE successive failures of Russian assaults on the defence lines of Finland seem to have inspired the Bolshevik commanders with a furious desire to hurt the Finns in any possible way. Consequently, masses of German bombers have been flying over and trying to destroy every town and village in the country. The one thing that Russia can always produce is quantity. She has lots of bombers and lots of bombs. The skill of her airmen is, however, of a low order, and many of the bombs have failed to explode. So, while much damage has been done, chiefly by incendiary bombs falling on wooden houses, the casualties have been comparatively slight.

Finnish airmen have hit back with all their strength. We find it hard to accept the story that one Finnish fighter shot down six Russian machines in less than four minutes; but, undoubtedly, their fighters have been giving a good account of themselves. Shortage of machines has been the chief handicap of the Finns, but help from outside has begun to arrive. Italians and other volunteers have taken part in retaliatory raids on Russian bases. The anxious question now is whether enough help from outside will reach Finland in time to enable her heroic soldiers and airmen to keep the Russians at bay.

A League of Nations. Finnish airmen prepare to set off an a Fokker C.10 which has a Bristol Pegasus engine. Note the streamline skis.

COMMERCIAL AVIATION

MANHATTAN'S SKYLINE : The air traveller to New York's new municipal airport obtains a totally different view from that seen at ground level.

NOISE and NUISANCE

"A. Viator" on Cotton Wool, the Civil Service, and Air Hostesses

SOMEWHAT on the principle that if you have to live in a prison cell, you may as well do the thing properly and tastefully, and have chromium-plated bars to the windows, one, at least, of the neutral air transport companies has gone in for what is described as one-way glass for its cabin windows. When you see the machine on the tarmac you think the windows are ordinary glass, for you can see the curtains inside and so forth. When the stuff first appeared it caused quite a flutter in official circles. Officials had to be led into the cabin, out of the windows of which you can see absolutely nothing, such is the quality of this queer glass, before they would believe that it was opaque.

I hear rumours of a forthcoming lecture on noise and nuisance in aircraft, and I can only assume that it will be an historical survey of the matter, ending up with the remark that in these days there is neither noise nor nuisance in a properly constituted air liner. I am not, of course, referring to some of the queer fish of the skies which aircraft manufacturers who manifestly hated their fellow men, including air pilots and passengers, flung on to a dazed and dejected market. I mean the normally good passenger 'plane, built for the job with due regard to the comfort of passengers, such 'planes, in fact, as were to be found on most successful routes just before the war. In these there is neither noise nor nuisance, unless a subdued droning is a noise, and unless it is a nuisance that this soothing murmur is apt to put one off to sleep.

Ten years ago railroad kings used to gloat because people had to stuff cotton wool into their ears before flying, and it was no real answer to point out, as I frequently did, that they (the railway companies) ought to issue their passengers with cotton wool to stuff into their eyes on account of the grit, coal, coke and cinders which poured in at the carriage windows.

But now things are very different and the air transport companies long ago sold their last remaining stocks of cotton wool to the Santa Claus Christmas Beard Manufacturing Co., Ltd. There are really very few examples of noise and nuisance in aircraft, unless one refers to the sad case of the gent. who had lunched to the limit and who then sang "Run, Rabbit, Run" in an otherwise quiet cabin whilst beating time methodically with his umbrella upon the bald head of a fellow passenger, thus committing a nuisance and a noise simultaneously. His record was, however, beaten in the piping times of peace when something like panic arose in a peaceful cabin owing to an injudicious steward serving a Herr Wasserbubbler with a bowl of broth which led to noise, nuisance and intense vibration all at once.

Commercial Aviation

"Kultur will out," as the steward remarked a little later when Herr Wasserbubbler was taken with hiccoughs so intense that the Captain sent his First Officer back to complain about the queer hammering noises in the cabin. Which reminds me that air-sickness, about which seafaring folk used to remark, "et tu, Brute," has now practically ceased to exist, whereas there is nothing one cannot do in that particular line on the ocean wave.

Germany is now rife with rumours of a subtle gas which will put all England to sleep whilst we are invaded. Answer: We could knock spots off any invader even when walking in our sleep.

There seems to be a certain amount of acrid comment about the thousands of infants and their mothers who have been re-evacuated back to London recently, whereas evidently the gay but pitch-black Metropolis is not yet safe enough for those splendid dare-devils of the Civil Service. I learn, for example, that there is little or no prospect of the Air Ministry, which, like Cæsar, has gone into permanent and extremely cosy winter quarters, leaving its fortified fastnesses somewhere in the vicinity if not west of Land's End.

But there. Has it not been laid down by no less an authority than Sir Miles Fromm-Stryfe, of the Ministry of Distant Alarums and Excursions, that when it comes to returning to London, courtesy demands a strict adherence to the slogan, "Women and children first"? "Moreover," says Sir Miles, winking so that you can hear his eyelid click, "this is no time to take a rash step, especially Londonwards, when experts in enemy countries assure us, not for the first time perhaps, that the Blitzkrieg is imminent."

Flying High

I was much impressed by Miss Margaret Morrison's new book "Flying High." It is the story of an English girl with Dutch connections who manages to obtain a job as a K.L.M. air hostess, largely by virtue of her capacity to speak Dutch. In itself the story is eminently readable and does not depend exclusively on the "air motif." There is no doubt that Miss Morrison has "got under the skin" of an air hostess on a big international company like K.L.M., and has fully grasped the significance of the great *esprit de corps* which exists in a concern of this sort.

Those who know K.L.M. pilots, crews, ground staff, higher executives and air hostesses intimately have told me that the picture painted in "Flying High" is an extremely accurate one. The democratisation of an Army may be a task which causes statesmen to fall by the wayside, but in their newest of all organisations, air transport, a genuinely democratic spirit exists side by side with a smart discipline.

Democracy

In an air transport company you may well find that a managing director, a senior pilot, a wireless operator, the chief of a department, and an air hostess can form a merry party around a table in a restaurant, but that when duty calls each member will jump to it with a snap and few armies will produce a smarter salute than the wireless operator will give to that same senior pilot on the tarmac, two minutes later.

These points are brought out in Miss Morrison's incidental character sketches, but the readers' main interest is held by the training, and later the daily life, of an air hostess, who in peacetime, may spend one evening in Paris, the next in Berlin, a third in Vienna, Budapest, Prague or Rome, with a fairly quiet fourth day flying from Amsterdam to London and back.

An air hostess' job is to study the company's clients, who may be a batch of terrified refugees, an Indian Prince, an apparently languid Englishman, or an apparently efficient and certainly loud-voiced Nazi official. Such experiences in a young girl of nineteen or twenty will not produce a shy, retiring Miss, but a young woman of the world, well able to look after herself, and much the better for her varied experience and her international point of view.

The characters in "Flying High," though entirely fictitious, come alive to the reader because the book is true to life, and by a master stroke the narrative ends with the leading characters discussing a genuine newspaper paragraph quoted in full from a London paper; an account of the shooting-up of a K.L.M. machine with an air hostess on board, early on in the present war.

Anyone interested in peacetime air-line work should read this book.

A. VIATOR.

Economy of Air Transport

IN an article under this title on page 75 of our issue of January 25, analysing the cost of American air transport, it was stated that no information was available on the amount which the Post Office recoups in the form of mail surcharges, as an offset against its annual mail payment to the internal airlines of something like $16,500,000. In all the calculations made this figure, which reduces Government expenditure, was neglected and Government contribution was taken as the full $16,500,000.

Aero Digest for January has an editorial on the subject of "Fair Mail Rates for the Airlines," and in it the statement is made: ". . . that the airlines are not subsidised by the Government, that they are not taking money from the taxpayers, for they are now getting in air mail payments as much money as the Post Office is receiving from the public through the sale of air mail stamps." If this is so, then Government contribution is nil and "civil aviation *is* flying by itself."

In any case, the low cost of civil aviation demonstrated in our article is even lower still.

Sir John Reith's Farewell

IN a message of farewell to members of the Airways staff, Sir John Reith expresses his personal regret that his appointment to be Minister of Information "automatically involves my relinquishing the Airways chairmanship." The transitional period which has led to the establishment of an Airways Corporation, the reorganisation and amalgamation of the staffs of Imperial Airways and British Airways had their difficulties, but, Sir John added, "The ready co-operation I received from all concerned made the way smoother than it might have been.

"The executive control of the two companies had already been assumed by Mr. Runciman last autumn, and it is most satisfactory to know that I can go without causing any dislocation or inconvenience."

A few weeks ago Mr. Leslie Runciman was appointed to be chief executive member of the Airways Corporation, with the title of Director-General.

Air Passengers Saved

AFTER a long delay it has now been stated that some of the passengers in the Imperial Airways machine which alighted on the sea off Sicily on December 21 were rescued by a small Greek sailing ship, the *Giuseppe Padre*, whose captain, Capt. Romano, displayed great seamanship. The pilot of the aeroplane, Capt. Fair, circled the vessel to attract attention, and then alighted a short distance ahead of her. The tiny lifeboat could only take three at a time.

The K.N.I.L.M. Accident

GREAT sympathy will be felt by aviation circles with the Royal Netherlands Indies Air Lines in connection with the accident that occurred to a Lockheed off Bali. The machine was on its way to Australia and carried five passengers, in addition to a crew of three. One of the passengers, Mr. Learoyd, was a London man and a director of Lustre Fibres, Ltd., a subsidiary of Courtaulds, Ltd. Another passenger, Mr. Douglas Harper, was one of the earliest members of the Malayan Flying Club. So far the cause of the accident has not been ascertained. The machine had left Bandoeng shortly before the crash into the sea.

London-Batavia

THE K.L.M. time-table issued on January 1, 1940, shows that the London-Batavia service is being run twice weekly. London to Naples is done by train, leaving Saturday and Tuesday evenings. The aeroplane is boarded at Naples, departing at 7.00 hours local time, each Tuesday and Friday. Batavia is reached the following Sunday and Wednesday, at 11.15 hours, from whence there is a Sunday departure by K.N.I.L.M. for Australia. The return leaves Batavia on Monday and Thursday, arriving Naples Saturday and Tuesday. The train connection arrives in London the following Tuesday and Friday mornings. Thus the London-Batavia journey, which formerly took seven days, still takes only eight days.

he will think that the rocket is doing no work but merely expending energy to prevent it acquiring a backward acceleration, like a hovering helicopter.

Finally, concerning the problem posed by Dr. Lanchester in his reply to Mr. Cleaver. Consider a small interval of time, dt, measured from the instant of starting, and let the acceleration of the mass, m, be $f = \frac{F}{m}$. Then useful work = FVdt.

Work input = $\frac{1}{2}fdt^2$, which is a small quantity of the second order and may be neglected.

But there is also a loss of K.E. which must be considered. This may be regarded in two ways: First, if we assume that the process is to be continued, so that we still have control over the mass, m, then loss of K.E. = $\frac{1}{2}$ m ($V^2 - V^2 + 2Vdv - dv^2$), where dv = fdt.

Neglecting second-order small quantities, this reduces to m v dv − m v f dt = F v dt, and η = 100 per cent.

But if we assume that no further acceleration is given to the mass, m, and we lose control of it at this point, all its K.E. is wasted. This K.E. = $\frac{1}{2}$m ($V^2 - 2Vdv + dv^2$), and $\eta \longrightarrow 0$ as $dt \longrightarrow 0$.

This is in agreement with the formula $\eta = \frac{2vV}{v^2 + V^2}$ for very small values of v, as would be expected.

Derby. C. L. JOHNSON.

IN his reply to my first letter, Dr. Lanchester accuses me of suggesting that the energy released by the combustion of the fuel in a rocket is a function of the velocity of the rocket. This, of course, I never did; it is with Dr. Lanchester's neglect of the kinetic energy of the fuel in his expression for input energy that I, in common with Messrs. Johnson, Helsdon and Lawrence, disagree.

If Dr. Lanchester defines his useful energy as being utilised in giving the rocket a velocity (V) relative to some agreed datum, then he should also define his input energy relative to that same datum.

The output of the combustion chamber is $\frac{1}{2}$ m/s v^2, which may be only some fraction of the original chemical energy fed in. This fraction is, however, the only part of that original energy which could possibly be utilised for propulsion, since the rest is merely wasted as the result of the thermal in efficiency of the combustion chamber; it is therefore the only part which can fairly be included in the denominator of an expression for propulsive efficiency.

However, relative to our old friend "the agreed datum" the fuel has, before combustion, some kinetic energy ($= \frac{1}{2}$ m/s V^2) in addition to the above. If the initial conditions for which we set out to evaluate the propulsive efficiency actually do obtain, then this term has to be supplied just as surely as that other term ($\frac{1}{2}$ m/s v^2) which is the result of the combustion of the fuel.

Both terms should therefore logically be included in the expression for input energy—otherwise, as Mr. Lawrence remarked, the theorem of the conservation of energy is being "slighted."

With regard to Dr. Lanchester's analogy at the conclusion of his reply to my letter, it seems to me that he is disregarding the only possible origin of his force F. Surely this force exists only as the result of the expenditure of some energy in giving the particle a velocity relative to the aeroplane, and it is therefore pure nonsense to talk of efficiencies of infinity on the grounds that no energy has yet been consumed, since none has yet been supplied either? In any case, the analogy leaves unaltered the arguments contained in this letter.

London, N.W.2. A. V. CLEAVER.

THE interest in Mr. Lanchester's articles has undoubtedly been stimulated by the effort sustained in trying to swallow his "over 100 per cent." efficiencies. Several of your correspondents have pointed out that Mr. Lanchester has been in error in omitting from the denominator of his expression for efficiency, the K.E. of the mass before ejection. In his own reply to Mr. C. L. Johnson (see issue of December 28) he states: ". . . When the rocket jettisons part of its mass and is left with diminished energy, the energy lost is not destroyed, it is made use of in propulsion. It is, in fact, this which supplies the energy to which is due the very high efficiency represented by equation (4) in the article in question."

Again, in the same issue in his reply to Mr. Lawrence, Mr. Lanchester writes: "No, the work done . . . . by expansion in the case of the problem of the exhaust efflux, is definitely $\frac{m/s\ v^2}{2}$ foot poundals per sec.; . . . . . And this being the energy expended (whole of the energy expended), this is the denominator in the expression for efficiency. . . ."

This statement, particularly emphasised by the words in brackets, seems to contradict the former. However that may be, let us approach the subject from a new angle. Using Mr. Lanchester's symbols, it is agreed that the work usefully performed = FV = m/sv. V. Furthermore, it will not be disputed that the exit velocity, in reference to the earth, of the ejected mass = V − v, and therefore, that the lost K.E. = $\frac{(V - v)^2 m/s.}{2}$

Since no other quantities are involved, the sum of these two must represent the total energy employed.

Thus total energy = E = m/s $[\frac{(V - v)^2}{2} + v.V]$ = m/s $\frac{(V^2 + v^2)}{2}$, which supports your correspondents above referred to. Clearly then, if the word "Efficiency" is to be used at all, its orthodox value can be no other than $\frac{2v.V}{V^2 + v^2}$

This does not mean that Mr. Lanchester is in error in his method of calculating final results. The source of the confusion and dismay of so many of your readers is due to the use of the term "Efficiency" for the expression $\frac{2v.V}{v^2} = \frac{2V.}{v}$ This does not correctly express efficiency, but is merely a ratio of the two quantities: m/s.vV and $\frac{m/s.v^2}{2}$; the former representing the gain in propulsion and the latter the energy, as efflux K.E. representing the assumed expansion value of the tail-end of the indicator diagram and without any allowance for the K.E. of the mass translation at velocity V. If Mr. Lanchester had not called this ratio "Efficiency" it is doubtful whether he would have had so many letters to answer!

Woodford Green. HEDLEY J. THOMSON.

A Contribution from Sweden

THE discussion raised by the problem of rocket efficiency seems to lead to the conclusion that the idea of efficiency is fundamentally inapplicable in this connection. Dr. Lanchester rightly points out that the energy expended by the combustion in the rocket has no connection whatever with the velocity of the rocket relative to the earth or any other datum except the rocket itself. He then makes the mistake of using the earth as a datum for measuring the useful work done, saying that the energy per second is rocket force F times velocity V, where V is measured relative to the earth.

But why take V relative to the earth? Why not relative to some heavenly body rushing in the opposite direction? The "efficiency" would then be literally astronomical. But it would have no meaning for the engineer. If we think of the rocket as a free body in empty space, the idea of efficiency can only have one meaning; that is, the kinetic energy imparted to the particles relative to the rocket, divided by the available chemical energy, incidental losses being due to heat radiation, etc. If the particles were all expelled in the same direction a certain force would then be available for accelerating the rocket

In the case of an aeroplane flying at constant speed the extra force would be an arithmetical addition to the thrust, irrespective of V, and could be expressed nondimensionally as a fractional improvement in overall efficiency, or as extra work done relative to the air divided by available energy of the exhaust gases. As other correspondents point out, if an energy balance sheet of the whole process from the start of the aeroplane or rocket from the ground is examined, yet another criterion of efficiency can be established. The maximum speed relative to the ground is obtained in the shortest time when the exhaust gases have no residual velocity relative to the same datum. F. H. TURNER (Whit. Schol.), G.I.M.E.

Linköping, Sweden.

Dr. Lanchester Elucidates

MR. CORBITT in his second letter (January 4, 1940) raises a new point, and is entitled to a further reply. I am not prepared to defend the final (fourth) article (December 14, 1939) as being a complete and precise demonstration. My object was to point out the intimate relation between the induction and the exhaust as affecting the problem of propulsion. Otherwise, with a compressible fluid, gaseous mixture or air, it would not be legitimate to introduce the Torricellian principle. In view of Mr. Corbitt's challenge, and as a final answer to my many critics, I submit the following:—

First, a few postulates. (1) The undisturbed state of the air, deemed to be "at rest" is taken as datum, see article I (November 16, 1939). (2) We admit of no mechanical losses, i.e., no energy may disappear from the dynamic system. (3) We confine ourselves to the condition in which the efflux air

or gas is *at rest*, that is, in the same condition as at influx:— v = V. (4) There is a phase during which the air or gas is brought to rest *relatively to the aeroplane*, that is to say, its velocity component in the direction of flight = V relatively to datum.

Using the same notation as previously, the force (drag) during the scooping up of the air in the induction system, due to the communication of momentum, is (m/s) V, and the energy per second = FV is therefore (m/s) V^2. But this air is now travelling with a velocity V and the energy per second is therefore $\frac{(m/s)\ V^2}{2}$, so that a quantity of energy (a difference) equal to this is not accounted for; by postulate (2) it cannot have disappeared. If we suppose the pipe, shown straight in Fig. 2a (see page 495, December 14, 1939), to be bent through a right angle as in Fig. 3a, the course of the air flow is diverted from the direction A A′ to B′ B. The momentum communicated is the same as before, − (m/s) V, for the air passing along the limb B′ B has the same momentum in the direction of flight as though it had been brought to rest relatively to the aeroplane. But in addition to the energy per second = $\frac{(m/s)\ V^2}{2}$ due to the velocity V in the direction of flight, we have now to take into account an equal amount of energy due to the motion of the air in the limb B′ B at right angles to the direction of flight, with velocity = V; so now the energy account balances. The two equal vectors indicating the velocity of the limb B′ B at right angles to itself (due to the motion of the aeroplane) O P, and the velocity of the air within that limb O Q, each equal to V, have for their resultant the velocity vector O R = V$\times\sqrt{2}$ and this is relative to datum; hence the energy per second is, $\frac{(m/s) \times (V\sqrt{2})^2}{2}$ = (m/s) V^2 so that, as before, the whole of the energy accounted for.

In Fig. 3b, two further limbs, C and D, have been added to represent the exhaust efflux system. We may imagine anything to happen as the air passes from B to C, provided that no mechanical loss takes place. For example, at B we may suppose the air be made to drive a turbine, and at C the air be impelled by a fan or blower of some kind, but if there is no loss of energy it will come to the same thing if we suppose the limb C to be a direct continuation of the limb B′ B, as shown dotted in the figure. Now we will suppose an observer aboard the aeroplane in a closed chamber through which the pipe BC passes, and let him record the the mass per second and the velocity of the air passing; then the mass per second will b e (m/s) — u nchanged. This velocity we will call v, which in this special case (although the observer has no means of knowing it) is equal to V. Assuming that the observer has means of measuring the work done, as would be the case if a blower or impeller of some kind were used at C to impart the velocity v; this blower would be doing work at a rate $\frac{(m/s)\ v^2}{2} = \frac{(m/s)\ V^2}{2}$. This is the work *performed* (per sec.) in the act of propulsion, but the energy released is twice this, since the velocity relatively to datum in the limb B′ B C is V × $\sqrt{2}$, which is the energy available for propulsion; that is to say, the propulsion efficiency is 200 per cent.

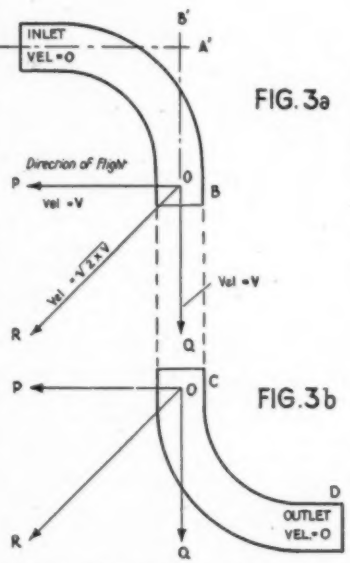


FIG. 3a

FIG. 3b

In accordance with postulate 1, the undisturbed air is taken as datum, both as concerns velocity and energy. The air in the limb B C partakes of the motion of the aeroplane in its flight, (postulate 4). The velocity of the air *along the limb* B C is incidental to the method of representation; it is a simple method of complying with postulate 2.

Although the conduit system figured does not represent or even resemble an actual layout, it serves to show clearly the source of the hidden energy that gives rise to the unexpectedly high efficiency. It is the energy due to the mass projected having originated as part of the aeroplane and as such being endowed with energy due to the velocity of flight, namely the horizontal velocity vector in Figs. 3a and 3b.

The theory of Torricelli is, strictly speaking, only applicable in the case of an incompressible fluid. But since the general analysis given in article I applies to fluids compressible and incompressible alike, the theory should yield concordant results. This is so. Nowadays we do not drag in "g" in equations in which it really plays no part; the pressure velocity relation is given by* $v = \sqrt{\frac{2p}{\rho}}$ in which p is pressure, and ρ density.

Fig. 4 is a diagrammatic representation of a rocket, showing a chamber containing fluid whose density is ρ, maintained at pressure = p, or rather p is a pressure difference, internal

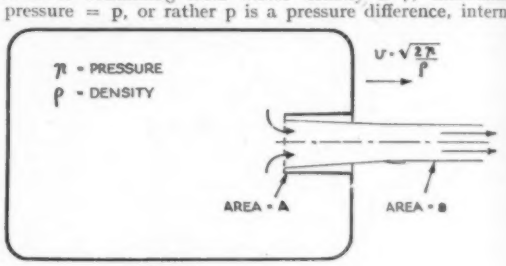


FIG. 4.

The principle, demonstrably true for the Borda nozzle, holds equally for any form of nozzle, whether it be a simple orifice or a tapered nozzle like that of a fire hose, but no known mathematical treatment is capable of giving a general solution. (Compare "Aerodynamics" Lanchester, 95—96. *Also* Proc. Inst. N. Architects, "Theory of Propulsion," 1915.)

minus external. The aperture, area A, is provided with a re-entrant or *Borda* nozzle, through which efflux takes place. When a fluid under pressure flows through an aperture, there is always some *contraction*, i.e., reduction of area. In the case of the Borda nozzle the degree of contraction is capable of exact calculation, the momentum per second of the issuing jet being equated with the resultant force due to the relief of pressure on an area equal to that of the aperture. Thus, referring to Fig. 4. The mass per second of the issuing jet = (m/s) = aρv ∴ momentum per sec. = F (force) = (m/s) v = aρv^2 = a$\rho \times \frac{2p}{\rho}$ = 2ap; but F = Ap ∴ A = 2a.

That is to say, the cross-sectional area of the jet is half that of the nozzle. This is a well-known result.

The energy per second imparted to the efflux jet = $\frac{(m/s)\ v^2}{2}$ = $\frac{(a\rho v).(2p)}{2\rho}$ = apv

And energy per second effective in propulsion = ApV = 2apV

∴ Efficiency = $\frac{2apV}{apv} = \frac{2V}{v}$ (See article I, equation (4).)

When in the act of passing the proof of the above for Press, I have received a letter of one more critic, Mr. Hedley J. Thomson, who goes over the same ground once more. As far as I can see the only new point he has introduced is that he has no objection to my expression 2V/v on condition that I do not call it efficiency; this is most kind! Unfortunately, in my first article (which perhaps Mr. Thomson has not read or may have forgotten) I defined the meaning of efficiency in the manner used universally in discussing the efficiency of the screw propellor or more generally of propulsion (page *d*, *Flight* Nov. 16th, 1939), and in discussing my thesis no other definition is permissible. The discussion was confined to the steady state of motion, i.e., V is taken as constant. And the characteristic which distinguishes efflux propulsion is that the body propelled is parting with its substance, and with its energy.

Now if we had been making an energy account from the time an aeroplane starts from rest to the time it comes to rest we should have found that some of the work done during acceleration had disappeared when it came to rest, and this energy is that which being expended in the propulsion of the aeroplane (or what is left of it) gives rise to the abnormal efficiency. But we are not drawing up such an energy account, we are dealing with a steady state of flight at velocity = V that is as given, and any other assumption would invalidate the treatment in its subsequent applications.

F. W. LANCHESTER.

* Derived thus:—$v = \sqrt{2gs}$; $p = sg + g$, or $s = p/eg$; ∴ $v = \sqrt{\frac{2p}{e}}$

THE EMPIRE TRAINING SCHEME

Further Details of Canada's Preparations

THE arrival in Canada a few days ago of 71 officers and about 200 airmen of the Royal Air Force indicates the passing of the first milestone in the progress of the Empire Air Scheme. Planning has been completed; now the scheme is under way. This party of officers and men are the instructional staff sent by the R.A.F. and will be drafted to five different stations: R.C.A.F. Headquarters at Ottawa, Air Training Command at Toronto, Technical School at St. Thomas, and to Trenton and Borden.

The supervisory board, under the chairmanship of Mr. Rogers, Canadian Minister for Defence, has held its first meeting and received a detailed report from Air Vice-Marshal Croil who is in charge of the scheme. Mobile units will be used to travel in remote rural areas for recruiting purposes and examination of recruits will take place in their own localities, so saving unsuitable recruits long and fruitless journeys.

Lord Riverdale, speaking in Sheffield on January 27, said that there would soon be a constant stream of young men pouring into Canada to get their final and complete training. Shortly after, they would be coming to this country and would prove a vital factor in winning the war.

Trainer Aircraft

News from Canada indicates that the provision of training aircraft is receiving due attention. Negotiations are under way with Canadian manufacturers for construction of 1,282 training 'planes to be built in Canada except for engines, which will be supplied from England. There are 870 complete airplanes on order in England for assembly in Canada, and 593 airplanes being manufactured for Canada in the United States. In addition, 1,622 airplanes without wings are on order in England for assembly in Canada with the wings to be built in Canada. The War Supply Board is organising the Canadian aircraft industry for maintenance and overhaul of the training aircraft and is establishing the necessary depots for overhauling aircraft engines. When the training programme is at its peak, it is expected that between 3,000 and 4,000 airplane engines will be overhauled every year, requiring a maintenance staff of about 10,000. DH Tiger Moths and Fleet Trainers will be used for primary training, while Harvards, Ansons, Battles and Oxfords will be in use for Service and advanced flying. R.C.A.F. personnel remaining in Canada will use Lysanders, Bolingbrokes, Hurricanes, Sharks, Stranraers and Douglas bombers.

An agreement has been reached by the Government and the 22 light airplane clubs in Canada whereby the flying clubs will provide 13 elementary schools for the scheme.

There will be a total of 67 training schools, with seven additional ones for instructors, administration, repair and equipment. Fifty-eight of the 67 will be for training air personnel, the rest for ground and maintenance staffs.

All recruits—future officers will be enlisted in the same way as all other ranks in accordance with the democratic principle—will have four weeks' ground training and will then be selected as pilots, observers or gunners. Pilots will then get eight weeks at one of the 13 elementary flying schools, followed by fourteen weeks of intermediate and advanced training at one of the 16 service flying schools.

Air observers will spend twelve weeks on reconnaissance and photography, then six weeks on bombing and gunnery. They will end their training with four weeks on advanced navigation. Air gunners will start with sixteen weeks on radio work and then four weeks on bombing and gunnery.

Rates of Pay

Under the Air Scheme pilots in training will be ranked as Leading Aircraftmen and as Sergeants on completion of training. Gunners will be Aircraftmen Class II in training, with possible promotion to Leading Aircraftmen when trained. Some pilots and observers will be given commissions on passing out of training. Pay will be at standard R.C.A.F. rates while personnel are in Canada. These are, per day: Pilot Officer, $4.25; Flying Officer, $5; Flight Lieutenant, $6.50; Squadron Leader, $7.75; Wing Commander, $10; Group Captain, $10. Officers on the general list who are under call to fly receive an additional $2.

Airmen's rates are as follows: Aircraft Apprentice, $1; Aircraftman II, $1.30; Aircraftman I, $1.40; Leading Aircraftman, $1.50; Corporal, $1.70; Sergeant, $2.20; Flight Sergeant, $2.50; Warrant Officer II, $3.10; Warrant Officer I, $4.20. Airmen receive an additional 75 cents per day if ordered to fly.

Allowances for wives of officers are: For officers above the rank of Squadron Leader, $60 per month; Squadron Leader, $55; Flight Lieutenant, $50; Flying Officer and Pilot Officer, $45; Warrant Officer I, $40; while allowance for wives of all other ranks is $35 per month. Male dependants under 16 and female dependants under 17 are allowed $12 per month, but maximum number of dependants allowed for, including wife, shall not exceed three.

Training in Rhodesia

RHODESIA will also take her place in the Empire Air Training Scheme. Equipment and the majority of the instructors and pupils will be sent to Rhodesia by the British Government, which will bear most of the cost. A contribution will also be made by the Southern Rhodesian Government. When trained, airmen will be posted to the Royal Air Force and Rhodesian Squadrons will be formed as soon as there are sufficient numbers of personnel available. Preparations are now being made for the reception of pupils, aircraft and equipment.

The Tallest Ever

LAST week something of a flutter was caused by the announcement in an American daily that "250 bombers" were flying the Atlantic *en route* for England. Needless to say, the story was pure invention, and it was somewhat surprising that more than one English evening paper "fell for it." Flying has not yet reached the stage when it is feasible to send such air armadas across the Atlantic, especially at this time of the year, when icing conditions and other nuisances are to be expected. Moreover, the usual wireless aids to navigation are not available during the war. And anyway, the Allies are not in such a hurry as all that about deliveries. The story had it that the machines were manned by Frenchmen, and that they were Lockheeds. So far as is known, France has not ordered Lockheeds.

Busy-ness at Wolverhampton

WHEN war broke out Mr. Lindsay Neale closed down his little company and got a commission in the R.A.F. He has now been relieved of service duties, at the request of Boulton Paul Aircraft, Ltd., in order to take up a post with them as assistant to their chief test pilot, Flt. Lt. Heather.

Next Week's Issue

WE consider ourselves fortunate in having obtained, for our Aircraft Construction Number next week, a number of interesting features. These include articles by such well-known technicians as Mr. W. O. Manning, Mr. Robert L. Lickley, and Mr. J. D. North. Between them they will deal with structural design in the past, present and future. Each of the three authors is particularly qualified to write on the subject he has chosen.

A Centenary

MONDAY next, February 5, will be the centenary of the birth of John Boyd Dunlop, the veterinary surgeon who invented the pneumatic tyre. In sheer numbers the humble bicycle has derived the greatest benefit, as it is estimated that there are 72 million of them in the world, running on 144 million air-filled tyres. The motor industry comes next. In 1938 British factories alone made 6½ million motor tyres. But aviation also would be in a sorry plight without the pneumatic.

PRE-AB INITIO

The New "Visual Link" Trainer

"Flight" photograph.

"Where the mountains o' Mourne." A pupil making a turn to port on the new Visual Link trainer.

IN what was the sun lounge on the promenade of a South Coast resort are a number of circular structures which house the new "Visual Link" Trainers which are now being used to give primary pilotage training to our Volunteer Reserve pilots.

The Link Trainer, it will be remembered, is a stub fuselage with wings and tail surfaces, "driven" by powerful bellows so that the movement of the normal flying controls in the cockpit will reproduce very faithfully the motions of actual flight. The pupil and instructor are in telephonic communication the whole time so that problems may be set and advice and correction given.

Hitherto the Link Trainer has been used solely for instrument (or blind) flying instruction of pilots already qualified. In this case the pupil is enclosed in a hooded cockpit and receives instructions to fly on a predetermined course while the actual course he would have flown is electrically recorded on a map by a contrivance known as a "crab."

The "Visual Link" Trainer differs from the original type in that the cockpit is open and the whole machine is surrounded by an aerial panorama of mountains, sunny countryside, littoral, smoky towns, clouds, seascape and misty horizon. This panorama is painted to represent a flying height of 2,000-3,000ft., and the illumination is varied in such a way as to complete the illusion of good or bad visibility. A top plane and centre-section have been added to give the impression of sitting in a Tiger Moth. The airscrew disc is realistically represented by a semicircle of celluloid on which abrasions have been made. There is a complete set of instruments on the dashboard, and standard throttle levers and controls are fitted. All the instruments give appropriate readings for the resultant of the position of the controls and the altitude of the machine. Thus, for instance, with nose down and engine full on the A.S.I. will go "right off the clock." A further refinement is a series of valves which will produce the effect of bumpy weather or icing conditions.

When the pupil gets aboard the Visual Link for the first time, he has had about six weeks' training, mostly disciplinary, during which he has been converted from a civilian to a soldier. His chest is an inch or two bigger than it was; his stomach has receded; his head is erect; his reactions have been smartened up by special drill games; and he has had lectures on elementary theory of flight and piloting.

Seated in the cockpit, he is told to assume a comfortable position, to hold the joystick lightly yet firmly, "as if it were made of glass," and to relax the knees. The Trainer is locked fore and aft, and the primary effect of the rudder is demonstrated by the machine turning to the right or the left when pressure of the feet is applied to the rudder bar. Next the machine is locked laterally and directionally and the primary effects of the elevators is taught. Following that, the Trainer is locked against directional and fore-and-aft movement, and the raising and lowering of the wings by the operation of the ailerons completes the study of the

primary effects of the three flying controls.

For the next lesson the joystick is held centrally by a spider of rubber cord, with the machine being free to move in all directions. With the Trainer in this condition the pupil is shown how, despite the fact that the stick is locked, the nose is depressed and a turn made to the right or left by the use of the rudder only. The elastic spider is then removed, and co-ordination of the three controls is practised. Gradually the pupil is able to do medium turns, climbing and gliding turns, and to finish facing in a desired direction or on a compass bearing given by the instructor. In the later stages of this practice, bumps are introduced as an added complication.

Spinning and recovery occupy the next session, the Trainer reacting to the apparent loss of flying speed in exactly the same manner as an ordinary aeroplane, except that—for mechanical reasons—the spin is of the flat variety. Nevertheless, the normal flying position cannot be regained until auto-rotation has ceased and sufficient speed is showing again on the A.S.I.

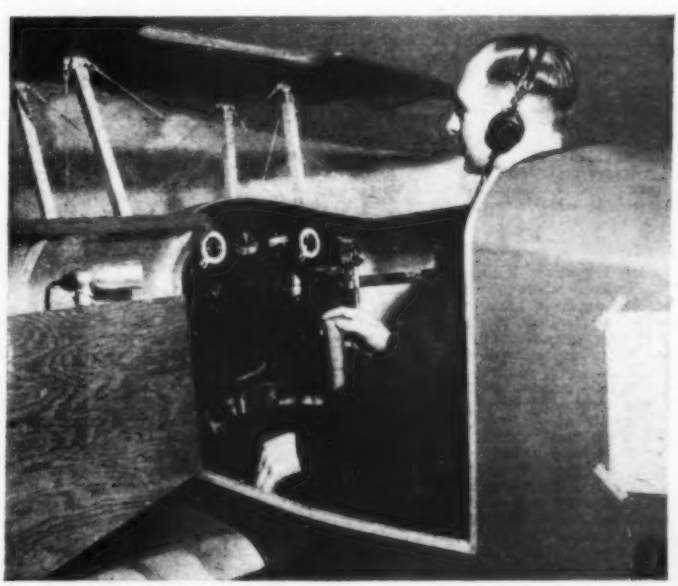
At about the same stage in the training period, the effects of icing are demonstrated. The closing of a valve shuts off the pressure to the air speed indicator, and at the same time puts the stalling speed up by some 10 m.p.h. The pupil is then apparently flying a machine which has little speed range and no speed indicator. All flying must be gauged by the engine revolution indicator, the visual horizon and/or the Sperry artificial horizon. He is then told that better conditions usually exist higher up, and he has to climb gingerly with the little excess of power he has in hand. If the bumps are "turned on" at the same time, this test requires the art of a Houdini.

"Flight" photograph.

Reactions are smartened up by special drill games. This one is called "Boat Race."

"Flight" photographs.

Above. The sergeant instructor goes over the instrument panel with a pupil. At the rear of the fuselage is an external coupled joy-stick which is used for demonstration by the instructor. Right. A close up of the Link cockpit showing the very complete instrument equipment.



Altogether, a pupil spends some eight hours in the Link "Visual" Trainer. The final sessions are devoted to such subjects as taxying, blind flying and the compass. Even Lorenz instruments are fitted for elementary practice. The instructors claim that they can pick out the "bowler hats" from these tests, but a man is not "failed" on Link results. He is sent on to a flying training school with the remainder of his term, but more often than not the pupils show up good or bad in much the same ratio as they appeared in this pre-*ab initio* flying.

The advantages accruing from the use of the Visual Link Trainer are obvious. It clips several hours off the real *ab initio* flying training, since the pupil starts with "hands" which, if not quite equal to the control of a Spitfire, have at least got well past the "white-knuckle" stage. The saving of petrol for more advanced training may not be terrific, but the saving is made and in wartime every little helps.

SERVICE AVIATION

Royal Air Force and Official Announcements

EDUCATIONAL : The French officer appears to view the model of the He 111 with some scepticism. The second is of a Junkers Ju 87.

Foreign Decorations

THE King has been graciously pleased to grant a general permission for the acceptance and wearing, without restriction, of decorations and medals conferred by the Allies upon British subjects of whatever category for services in connection with the prosecution of the war.

Duke of Kent Visits H.Q. Fighter Command

ON January 24 Rear-Admiral H.R.H. the Duke of Kent visited Headquarters, Fighter Command, Royal Air Force. The Duke was received and taken on a tour of inspection by Air Chief Marshal Sir Hugh Dowding, Air Officer Commanding-in-Chief, Fighter Command.

Vultees for the R.A.F.?

SQN. Ldr. J. R. Addams, British Air Ministry representative in the United States, has tested a number of military aircraft types apart from the Lockheed Hudsons. It seems that he was particularly impressed with the characteristics of the new Vultee Vanguard single-seater fighter, the first picture of which was published by *Flight* on December 28, 1939. The Vanguard is an exceptionally finely streamlined low-wing monoplane fitted with one of the new fully cowled Pratt and Whitney Double Wasp two-row radials of over 1,500 h.p.; one version is said to give 1,600 h.p. at over 20,000ft. Cooling air for the engine enters through an adjustable scoop in the extreme nose and there are gills on the trailing edge of the long-chord cowling. Details of armament have not been released but it is not likely that the Air Ministry would consider anything less formidable than the eight rifle-bore Brownings as fitted on the Hurricanes and Spitfires. If the machine is adopted by the U.S. Government it will probably be armed with 0.5-in. Prestone-cooled Brownings, which are capable of firing explosive ammunition.

Lockheeds' Beat Schedule

THE last of the initial order for 250 Lockheed Hudson reconnaissance bombers left the assembly line at Burbank late in November, 7½ weeks in advance of contract date. The company maintained an average production of six of these machines a week. The order amounted to about twenty-seven million dollars and was placed on June 23, 1938, the first Hudson being delivered on January 12, 1939. It is believed that apart from additional Hudsons the Lockheed Company will deliver to the R.A.F. 200 bombers of a newer, larger and faster type. This may be of entirely new design or possibly a military version of the four-engined Excalibur. In civil form this machine, which is a low-wing monoplane, is estimated to have a top speed of 253 m.p.h. at 7,000ft. when fitted with four Pratt and Whitney Wasps, though the installation of Wright Cyclones will raise this to 263 m.p.h. at 15,300ft. The range with the latter engines on half power should be just over 2,000 miles and the absolute ceiling about 26,000ft.

It is reported from New York that the Lockheed Aircraft Corporation is to build an aerodrome at Pembina, North Dakota, to facilitate the delivery of aircraft over the Canadian border. A part of the aerodrome will be in Canada. It is understood that other companies manufacturing aircraft for the Allies will be allowed to make use of it.

Poles in the R.A.F.

HUNDREDS of Polish airmen have arrived in this country to join the Royal Air Force, and last week were inspected by Sir Kingsley Wood at a British aerodrome.

Higher Command

AIR VICE-MARSHAL R. WILLIAMS, Royal Australian Air Force, has been promoted to the rank of Air Marshal and will probably be appointed to command Empire air training in Australia. Air Vice-Marshal Williams is at present Officer in Charge of Administration, Coastal Command.

R.A.F. Comforts Appeal

THE Royal Air Force Comforts Committee appeal to their helpers throughout the country to send woollen garments and other comforts to their headquarters at Berkeley Square House, Berkeley Square, W.1. Issues made direct to local R.A.F. units and to individuals are much appreciated, but the official Comforts Committee in London cannot meet all requests for R.A.F. personnel serving in France and at isolated units at home unless the bulk of the available goods are sent to them. At the moment about 100,000 various woollen items are required to meet existing demands.

County and town comforts organisations and working parties should, therefore, send garments and other articles direct to Berkeley Square House as soon as completed without waiting until the full projected quota is ready. Needless to say "woollies" of all types—socks, scarves, mitts, etc., will be much appreciated this cold weather.

RULING INTEREST : The Maharajah of Nepal, who has been a guest of the Government of India, studies the Vickers gas-operated K gun in the power-operated turret of a Bristol Blenheim.

DOUGLAS BOMBERS FOR CANADA: Twenty large twin-engined bombers generally similar to the Douglas B-18s used by the U.S. Army Air Corps are being delivered to the Royal Canadian Air Force. The first one is seen being towed over the border in accordance with the cash-and-carry provisions of the Neutrality Law which prevent aircraft being flown across. The nose design is interesting; the upper projecting portion is the bomb-aimer's position and the sphere below houses a machine gun.

Casualties

THE Air Ministry regrets to announce the following casualties on various dates:—

KILLED IN ACTION.—P/O. R. G. A. Barritt (76454), Sgt. J. A. Brister (580846), L.A/C. A. G. Goodenough (533017), A/C.2 A. A. Wilson (621397), Cpl. R. Wilson (566297).

PREVIOUSLY REPORTED "MISSING, BELIEVED KILLED," NOW REPORTED "KILLED IN ACTION."—A/C.1 A. Sill (520315), A/C.1 A. Thomason (530618).

PREVIOUSLY REPORTED "MISSING," NOW REPORTED "KILLED IN ACTION."—A/C.1 J. W. Cumming (523342), A/C.1 J. A. Garrick (567306), Sgt. R. E. Herd (564710), Sgt. W. H. Stephens (580680).

MISSING, BELIEVED KILLED IN ACTION.—Act. Flt. Lt. T. H. Clarke (37960), L.A/C. C. F. Hudson (524576), Sgt. R. J. Peacock (562854), L.A/C. D. M. Rowson (530700).

MISSING.—Sgt. W. Anderson (580390), F/O. J. E. Atkinson (39640), F/O. D. C. E. Bailey (39924), P/O. M. I. Drawwater (40374), Sgt. T. A. Kerr (700116), L.A/C. J. M. F. Key (520262), Act. Sgt. W. H. C. Kidd (563851), P/O. K. Laxton (70389), L.A/C. T. V. Lewis (531954), L.A/C. A. J. Mantle (521552), L.A/C. T. L. Marlin (550205), Sgt. J. Morrice (580290), F/O. A. T. Thompson (39353), Act. Sgt. A. J. Tilley (513066), Sgt. H. W. Tyrrell (516328), Sgt. H. R. B. Wakeham (563597).

KILLED ON ACTIVE SERVICE.—Act. Sgt. R. J. Bailey (581258), Sgt. F. F. Bousfield (565845), F/O. R. Coe (39273), Act. Sgt. T. O. Dennis (518112), Flt. Sgt. T. D. Dixon (562485), A/C.2 T. A. Gratton (615803), Sgt. F. F. Hallam (564213) Cpl. D. Irving (520562), A/C.2 J. R. Lewis (626981), Act. P/O. J. A. Littlewood (42617), P/O. H. M. Macgregor (41855), P/O. A. H. Maguire (42015), Act. P/O. A. J. Mathew (42250), Sgt. E. G. P. Mullinger (564751), Act. P/O. A. J. Mullock (42423), P/O. D. L. Payne (33163), P/O. M. V. Reynolds (41617), L.A/C. A. W. Smith (550814), Sgt. H. J. Steeley (565152), Flt. Lt. T. M. Tinker (34254), A/C.2 F. Waters (636421), Sgt. F. W. Whyte (338170).

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—A/C.2 V. Bishop (530720), P/O. J. D. Williams (40583).

DIED ON ACTIVE SERVICE.—A/C.2 D. Bright (935091), A/C.1 M. Campbell (147682), A/C.2 W. A. Colebourne (627020), A/C.2 W. Crossland (643734), F/O. C. D. Curtis (30861), A/C.2 E. J. Giddings (624499), Flt. Sgt. F. Harrison (313113), L.A/C. J. T. Jackson (509406), A/C.2 S. V. Maxted (902068), A/C.2 J. T. Merrifield (167660), A/C.2 G. D. Richards (908727), L.A/C. R. C. Widmer (330605), A/C.2 W. M. Wood (635600).

Royal Air Force Awards

THE Air Ministry announces:—The King has been graciously pleased to approve of the following awards to members of the Royal Air Force in recognition of gallantry displayed in flying operations against the enemy.

Awarded the Distinguished Flying Cross

Sqn. Ldr. (Act. Wing Cdr.) Richard Kellett, A.F.C.

This officer displayed courage, coolness and determination in leading his squadron and a combined formation of 24 aircraft in operations over an enemy naval base in December, 1939, which resulted in the infliction of heavy casualties on enemy aircraft.

In spite of the formidable opposition by aircraft and ground defences he so controlled the formation for which he was personally responsible that casualties were slight. By his personal example and cool leadership he won the confidence of all pilots under him.

Awarded the Distinguished Flying Cross

P/O. Cedric Alan Sykes Greenhill.

Awarded the Distinguished Flying Medal

A/C.1 Leonard James Britton.

P/O. Greenhill and A/C. Britton were pilot and rear gunner respectively of an Anson aircraft which, while on reconnaissance duty over the North Sea during November, 1939, was attacked by a Heinkel seaplane. P/O. Greenhill returned the attack, and by using to the full the manœuvrability of his aircraft gradually took the initiative.

A/C. Britton showed his ability by firing whenever possible.

The enemy aircraft was finally shot down by P/O. Greenhill, who delivered a short burst from his front gun.

Awarded the Distinguished Flying Medal

A/C.1 Charles Ronald Driver.

A/C. Driver was the front gunner in an aircraft engaged in operations over an enemy naval base in December, 1939. Although the aircraft was subjected to very heavy fire he remained at his post until both the front guns were put out of action and the flooring was shot away or in flames. He put out the flames with his hands.

By this time the petrol system had been severely damaged. A/C. Driver went to the hand petrol pump and continued manual pumping until shortage of petrol caused the aircraft to land in the sea.

Despite these exertions A/C. Driver subsequently succeeded in launching the dinghy, and assisted in saving the remainder of the crew, some of whom were wounded. It was largely due to his exertions that the crew of this aircraft were brought to safety.

Awarded the Distinguished Flying Medal

A/C.1 James John Mullineaux.

A/C. Mullineaux was rear gunner in an aircraft of a formation which carried out operations over an enemy naval base in December, 1939. In spite of heavy enemy anti-aircraft fire and repeated attacks he displayed great courage and coolness, bringing down by well-controlled and accurate markmanship, one enemy fighter in flames. In conjunction with his under turret gunner he destroyed a second aircraft.

Awarded the Medal of the Military Division of the Most Excellent Order of the British Empire for Meritorious Service

Sgt. Benjamin Joseph Traynor, The Green Howards (Alexandra, Princess of Wales Own Yorkshire Regiment). (Territorial Army).

L.A/C. Alfred Gorring.

In October, 1939, a Whitley aircraft, while taking off from an R.A.F. station with a crew of nine, stores and 30,000 rounds of ammunition, crashed, exploded and burst into flames. Sgt. Traynor and L.A/C. Gorring ran to the scene, and, despite the fire and continually exploding ammunition, extricated an airman who had been badly injured.

During this operation the oxygen tank blew up, but the men were not deterred from their gallant action, which resulted in the saving of the airman's life.

One other airman crawled from the rear turret of the aircraft. The remaining members of the crew were killed.

Royal Air Force Gazette

Royal Air Force

General Duties Branch.

The following Pilot Officers on probation are confirmed in their appointments on the dates stated:—(Sept. 5, 1939) P. J. C. King; (Oct. 30, 1939) E. Coton, H. H. B. Mould; (Nov. 3, 1939) P. D. Tunstall; (Dec. 28, 1939) L. G. Bishop, D. J. Harkness, D. W. Holford.

The following Acting Pilot Officers on probation are graded as Pilot Officers on probation on the dates stated:—(Dec. 16, 1939) G. H. Russell, F. W. Gilmore, R. B. Barrett, B. J. Hooper, G. Washington, A. B. Lawton, H. J. Mann, C. W. Doggett, A. Fitz-G. Fenton, C. D. Francis, T. A. Hampton, M. W. Hartford, G. M. Head, D. M. Lake, V. H. Rowan, T. C. Stanbury, L. E. Giles, W. G. M. Lambie, J. A. D. McLean, A. G. Wright; (Dec. 27, 1939) L. G. Bishop, A. H. Maguire, J. W. E. Alexander, K. G. Hart, I. C. Moorwood, K. Schadtler Law, N. H. J. Smith, D. W. A. Stones, M. A. Bentley, M. V. Carpenter, J. R. Urwin-Mann.

The following Flying Officers are promoted to the rank of Flight Lieutenant on the dates stated:—(Jan. 12) J. A. Field, C. B. B. Wallis; (Jan. 16) H. R. Johnson, G. A. H. Kent, C. L. Page, H. R. A. Beresford, A. C. Rabagliati, H. H. A. Ironside, P. A. M. Stickney, A. G. F. Cuningham, C. F. Darbishire.

Service Aviation

The following Pilot Officers are promoted to the rank of Flying Officer on the dates stated:—(Oct. 8, 1939) T. F. S. Breeton; (Nov. 16, 1939) R. J. Fayne.

Air Marshal Sir C. S. Burnett, K.C.B., O.B.E., D.S.O., is granted the acting rank of Air Chief Marshal (unpaid) (Jan. 1).

The following Flying Officers relinquish the acting rank of Flight Lieutenant on the dates stated:—(Dec 4, 1939) B. Romanoff; (Dec. 6, 1939) R. D. B. Macfadden; (Dec. 8, 1939) L. M. Gaunce; (Jan. 11) J. A. Richardson.

P.O. W. J. M. Longmore relinquishes the acting rank of Flight Lieutenant (Sept. 12, 1939); P/O. P. R. W. Wickham takes rank and precedence as if his appointment as Pilot Officer bore date June 17, 1938. Reduction to take effect from Dec. 7, 1939; Sqn. Ldr. A. P. F. M. Berkeley is placed on the retired list on account of ill-health (Jan. 18); the short service commission of Acting Pilot Officer on probation J. R. Coplans is terminated on cessation of duty (Jan. 8).

Equipment Branch.

A. R. T. Beddow is granted a permanent commission as Pilot Officer on probation (Jan. 8). The short service commission of Pilot Officer on probation D. A. D. Hoare is terminated on cessation of duty (Jan. 22).

Accountant Branch.

The following Flying Officers on probation are confirmed in their appointment:—(Dec. 21, 1939) F. T. Sceney, D. F. Allen, M.M., A. Still, J. Lee.

Medical Branch.

The following Flight Lieutenants are granted permanent commissions in that rank on the dates stated:—(Jan. 4) J. C. Taylor, M.B., Ch.B., W. T. Buckle, M.B., Ch.B.; (Jan. 7) J. S. Wilson, M.B., Ch.B.

Commissioned Armament Officer.

W/O. C. E. Edge is granted a permanent commission as Flying Officer on probation with effect from Jan. 5, and with seniority of June 19, 1939.

Royal Air Force Reserve

RESERVE OF AIR FORCE OFFICERS.

General Duties Branch.

Acting Pilot Officer on probation P. J. McNally is confirmed in his appointment and graded as Pilot Officer (Oct. 27, 1938); Flt. Lt. F. T. K. Bullmore is promoted to the rank of Squadron Leader (Aug. 28, 1939); Flt. Lt. D. S. E. Vines is promoted to the temporary rank of Squadron Leader (Jan. 1).

The following Flying Officers are promoted to the rank of Flight Lieutenant:—(Sept. 3, 1939) G. L. Blake, V. W. Soltau, A. N. Francombe, R. E. La F. Wyatt, C. M. D. Chambers, G. E. B. Stoney, N. P. Samuels.

The following Pilot Officers are promoted to the rank of Flying Officer on the dates stated:—(Sept. 8, 1939) T. P. De La Rue; (Oct. 15, 1939) W. J. E. Craigen; (Nov. 10, 1939) P. W. Lynch-Blosse; (Nov. 20, 1939) C. Clarke.

F/O. H. C. Devitt is transferred to the Administrative and Special Duties Branch in his present rank and seniority (Aug. 29, 1939).

The following Flight Lieutenants relinquish their commissions in class CC on cessation of duty:—(Dec. 5, 1939) J. W. Fraser, K. Horan.

The following Flight Lieutenants relinquish their commissions in class CC on appointment to commissions in the Royal Air Force Volunteer Reserve:—(Sept. 1, 1939) S. R. Sunnucks, J. R. Truscott, F. Whilton, D.C.M. (Flt. Lt., R.A.F., Ret.).

Flt. Lt. C. E. C. Penny relinquishes his hon. commission on cessation of duty (Dec. 3, 1939); F/O. L. G. Sparrow relinquishes his commission on account of ill-health (Jan. 24); F/O. G. L. Woodbridge relinquishes his honorary commission in class C on appointment to a commission in the Royal Air Force Volunteer Reserve (Sept. 1, 1939).

Administrative and Special Duties Branch.

F/O. R. H. Stainforth, O.B.E., resigns his commission (Jan 20).

Royal Air Force Volunteer Reserve

General Duties Branch.

The following are granted commission for the duration of hostilities in the ranks and on the dates stated:—Flying Officers: (Oct. 3, 1939) S. M. M. Watson; (Dec. 9, 1939) Sgts. G. H. Bowes, B. C. Frost. Pilot Officers: (Dec. 9, 1939) Sgts. T. Allitt, R. G. Buck. Pilot Officers on probation: (Dec. 4, 1939) Sgts. J. J. Veasey, J. F. Marsh; (Dec. 10, 1939) Sgts. J. R. Buchanan, M. L. Haigh; (Dec. 17, 1939) Sgt. J. D. Hargreaves, L.A/C. G. W. Brundish, E. G. Jones, W. C. A. Lodge, J. Marshman, V. A. Rendell.

The following Sergeants are granted commissions for five years as Pilot Officers on probation with effect from Jan. 1, and with seniority of Mar. 29, 1939:—S. P. Hagger, I. C. M. Sanderson.

Flt. Lt. R. R. Money relinquishes his hon. commission on cessation of duty (Dec. 4, 1939).

Administrative and Special Duties Branch.

The following are granted commissions as Flight Lieutenants with effect from Sept. 1, 1939, and with seniority of the dates stated:—(Jan. 24, 1936) Lt. J. H. Truscott (R.A.R.O.); (Mar. 23, 1936) Lt. Cdr. S. R. Sunnucks (R.N., Ret.); (June 15, 1938) Cdr. C. W. Parker (R.N., Ret.); (Sept. 1, 1939) Wing Cdr. B. F. Moore (R.A.F., Ret.), Capt. J. P. K. Groves, Lt. Cdr. G. L. Woodbridge (R.N., Ret.), W. E. C. Kendle, W. Miller, D.F.C.

Lt. G. M. Lindo is granted a commission as Flight Lieutenant (Sept. 1, 1939). (Substituted for notification in *Gazette* of Dec. 12, 1939.)

The following are granted commissions for the duration of hostilities as Pilot Officers on probation on the dates stated:—(Nov. 8, 1939) A. H. Keenan, D.S.O., O.B.E., M.C.; (Nov. 16, 1939) A. M. Thomson; (Dec. 6, 1939) R. J. Wootton; (Dec. 9, 1939) A. D. Forster; (Dec. 22, 1939) G. D. Gibson; (Dec. 28, 1939) F. A. Douglas, F. Horsley; (Dec. 29, 1939) H. P. Flack, D.C.M., R. Mc. Galway, G. F. M. P. Thompson, W. E. Tollworthy; (Dec. 30, 1939) V. G Hopkins, W. J. P. Sloan, S. H. White; (Dec. 31, 1939) C. W. Archan, P. M. Chettle, C. F. Croisdale, C. S. Fell, E. G. Jackson, J. L. Longden, A. H. Lynall, R. A. S. Moss, L. Pearl, J. E. Pipe, T. R. Robson, R. M. Rowland; (Jan. 1) T. G. W. Gardiner-Robinson; (Jan. 2) M. A. A. R. Pryce; (Jan. 7) R. Dick-Larkham; (Jan. 8) S. G. M. Bowman, A. B. Spence; (Jan. 16) H. C. Biles.

F/O. G. D. Hamilton is promoted to the rank of Flight Lieutenant (acting Squadron Leader (unpaid)) Sept. 1, 1939.

The following Pilot Officers on probation are confirmed in their appointments and promoted to the rank of Flying Officer on the dates stated:—(Aug. 11, 1939) G. S. Airey; (Aug. 31, 1939) L. C. Belcher; (Sept. 1, 1939) D. M. Faure, G. M. J. Hickman; (Sept. 2, 1939) K. J. G. Bartlett; (Sept. 4, 1939) J. P. Graham, T. C. Howland, W. J. Smith; (Sept. 5, 1939) A. J. Furze, C. F. Halford; (Sept. 7, 1939) A. Adderley, H. Ashman, F. J. Balcombe, J. H. Boyer, H. E. Bromley, I. R. Davies, C. L. D. Duckworth, D. Edgar, J. Evans, A. Foden, F. W. Griffiths, E. J. Harrington, P. L. Harris, K. Hassall, J. R. Jones, W. E. Kemp, J. Luff, K. G. Macmillan, R. J. Owen, F. L. Poyser, W. A. Russell, C. H. Salt, W. Thomson, W. R. Thomson, G. H. Thorndike, R. Turner, J. W. W. Whitehead, T. W. Wiseman; (Sept. 8, 1939) E. J. Ashby, G. H. Currall, M.M.; (Sept. 9, 1939) H. Meredith, M.C.; (Sept. 10, 1939) R. I. P. Barker; (Sept. 11, 1939) R. Musgrave; (Sept. 12, 1939) S. W. Tinham; (Sept. 13, 1939) C. O. Hinks; (Sept. 14, 1939) R. W. Napier; (Sept. 17, 1939) E. G. Bennison; (Sept. 22, 1939) J. F. Sanders; (Sept. 25, 1939) T. Waitt; (Sept. 26, 1939) J. C. Lawrence; (Oct. 12, 1939) W. E. Humphreys; (Oct. 13, 1939) R. L. Farley; (Oct. 24, 1939) A. E. White; (Nov. 5, 1939) H. W. Gil.

The following Squadron Leaders relinquish their commissions on account of ill-health (Jan. 20):—H. Manley, J. F. D. Tanqueray.

Equipment Branch.

The following are granted commissions as Flight Lieutenants with effect from Sept. 1, 1939, and with seniority of the dates stated:—(July 25, 1936) Flt. Lt. F. Whilton, D.C.M. (R.A.F., Ret.); (May 12, 1939) Maj. N. D. Williams.

The following Pilot Officers are promoted to the rank of Flying Officer on the dates stated:—(Oct. 12, 1939) S. J. Berry, H. A. S. Gothard; (Nov. 30, 1939) G. J. Bulman; (Dec. 14, 1939) A. L. Smith; (Dec. 21, 1939) A. L. Allen, G. N. Ricks; (Dec. 28, 1939) H. G. Hanks, J. S. Thomas; (Jan. 2) R. H. Johnson, F. A. H. Smail; (Jan. 5) C. M. Berkeley, J. G. Davis; (Oct. 12, 1939) H. C. Chatterley; (Nov. 10, 1939) A. C. R. Pearce; (Nov. 17, 1939) T. D. McA. Boyland; (Dec. 7, 1939) T. G. P. Hidson, L. D. Neeves; (Dec. 21, 1939) P. F. Humphreys, C. D. King; (Dec. 28, 1939) A. D. Hadler, K. V. McKenzie, W. Royle; (Jan. 5) R. E. W. Little.

Accountant Branch

The following are granted commissions as Flight Lieutenants (Sept. 1, 1939):—Payr-Lieut. R. L. Morgan (R.N., Ret.), Payr-Comdr. J. G. Derry (R.N., Ret.).

E. R. Bosley is granted a commission for the duration of hostilities as Pilot Officer on probation (Sept. 4, 1939).

Medical Branch.

The following are granted commissions for the duration of hostilities as Flying Officers on the dates stated:—(Dec. 12, 1939) T. A. W. Edwards, M.B., B.Chir., M.R.C.S., L.R.C.P.; W. R. May, M.R.C.S., L.R.C.P.; (Dec. 19, 1939) K. G. Bergin, M.B., B.Chir., M.R.C.S., L.R.C.P.; M. R. Chassels, M.B., Ch.B., C. R. Hamand, L.R.C.P., and S., L.R.F.P.S., W. R. Mackie, M.B., Ch.B., E. B. Nicol, M.B., Ch.B., D. Stafford-Clark, M.B., B.S., M.R.C.S., L.R.C.P., D. A. P. Stephen, M.B., Ch.B.; (Jan. 1) J. G. Molony, M.B., B.Ch.

Legal Branch.

The following are granted commissions for the duration of hostilities as Flight Lieutenants on the dates stated:—(Dec. 18, 1939) H. Elam; (Jan. 3) J. W. P. Clements.

Errata.

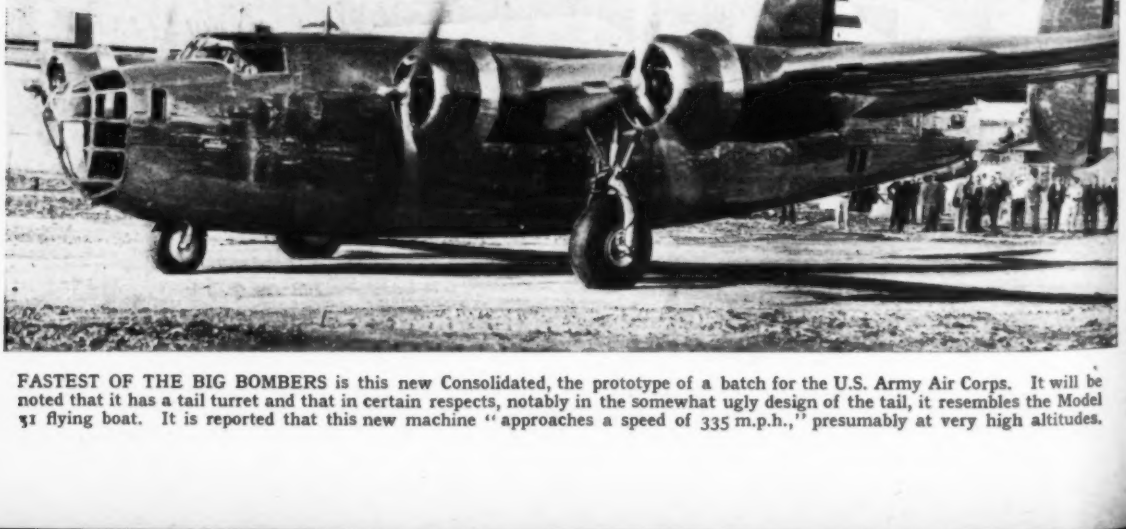
In the *Gazette* of Oct. 20, 1939, for Lionel Oswald Atkins, read Lionel Oliver Atkins; in the *Gazette* of Dec. 12, 1939, notification concerning E. W. Bitmead, for 754854 read 745954; notification concerning L. O. Halls, for 747807 read 747804; in the *Gazette* of Dec. 19, 1939, notification concerning E. Lyon, for Dec. 9, 1939, read Sept. 12, 1939; in the *Gazette* of Jan. 5, for the Rev. J. Grudgeon read the Rev. J. Grugeon.

Auxiliary Air Force

General Duties Branch.

No. 615 (COUNTY OF SURREY) SQUADRON.—C. D. Strickland is granted a commission as Acting Pilot Officer on probation (Sept. 1, 1939).

No. 907 (COUNTY OF MIDDLESEX) SQUADRON.—Flying Officer H. Elam relinquishes his commission on appointment to a commission in the Legal Branch of the Royal Air Force Volunteer Reserve (Dec. 18, 1939).



FASTEST OF THE BIG BOMBERS is this new Consolidated, the prototype of a batch for the U.S. Army Air Corps. It will be noted that it has a tail turret and that in certain respects, notably in the somewhat ugly design of the tail, it resembles the Model 31 flying boat. It is reported that this new machine "approaches a speed of 335 m.p.h.," presumably at very high altitudes.

STALL WARNING

C.M.W. Stall Indicator Tested in Australia : Light or Hooter? Reserve Airspeed Indicator

THE accidental stall is still a grave danger and causes a large proportion of the accidents which happen to private aircraft. Stalling of large aircraft in the transport class is, of course, very rare, but it cannot be said that even this has been entirely eliminated.

A device which indicates the approach of the stall has been designed and made in Australia by Mr. C. Murray Waller, of Sydney. It works by means of a venturi placed in the airstream, and is arranged to operate a warning light on the dashboard before the stall occurs. By an adjustment, the margin of warning given to the pilot may be set to any desired figure in terms of airspeed. The light may be made to come on when flying speed has fallen to within 5 m.p.h. of stalling speed, or 10 or 15 m.p.h. warning may be desired. Once set, the margin will not alter.

In external appearance, the device consists of the venturi connected by tubing to a small cylinder, of about 4in. diameter and the same length, which is set inside the wing of a large aeroplane, or outside it if the aeroplane is small. In the latter case it is suitably faired to reduce drag. From the cylinder electric wires go to the battery and dashboard light.

Though details of construction are not disclosed, it is obvious that pressure variations in the venturi (caused by varying speed of flight) operate an electrical contact in the cylinder and so light the warning lamp if airspeed drops below the predetermined safe figure.

The adjustment of the margin of warning is made by removing a cover on the cylinder and setting and fixing a pointer. With the cover replaced, unauthorised persons cannot tamper with the setting.

Tested in Flight

A test flight in a Puss Moth with the C.M.W. Stall Indicator fitted was an interesting event. With the aeroplane stationary no light showed. The glass in the warning light was dark orange in colour—why this had been chosen in preference to the conventional red for danger is not known. In the take-off the light came on soon after starting the run (at about 20 m.p.h.) and stayed on till past the stalling speed. While it still showed, the pilot knew his flying speed was insufficient to pull off safely. Having attained about 3,000ft. of height, a straight stall was tried. Throttling back, the pilot kept the nose high and speed fell and fell. Then, with a couple of preliminary flickers, on came the light. As yet there was no sign of stalling, although any pilot would have felt the aeroplane was "limp." Then a little slower still, and the pilot was obviously tensed up waiting for the stall and keeping the aeroplane on an even keel by rapid, jerky sideways movements of the stick. Finally, as though the struggle had rather wearied it, the Puss sagged away completely and attempted to put its left wing down. This the pilot prevented, and a recovery to flying speed in the glide was made.

The light had come on at about 10 m.p.h. above the stall, at which speed it had been set to come on. After several more straight stalls, medium turns were done and speed reduced to stalling while keeping bank constant. Stalling speed on the turn is, of course, increased by the bank. In these turns the light came on at the same A.S.I. reading as when flying straight; so, of course, the margin of warning was decreased. But up to a 45-deg. banked turn the device still gave its warning before the stall.

Theoretically, increases of stalling speed in banked turns are: 30 deg., 7 per cent.; 45 deg., 19 per cent.; 60 deg., 41 per cent. If stalling speed of an aeroplane is 50 m.p.h., these increases amount to 3½ m.p.h., 9½ m.p.h. and 20½ m.p.h. respectively.

Stalling speed is a difficult thing to determine accurately in the air, but the impression was quite definite that, up to 45-deg. bank, the light gave warning before the stall. It is, of course, a limitation of the C.M.W. Stall Indicator that it is a true stall indicator only for stalls in straight flying, but pilots who are going to do turns over 45 deg. should not need an indicator or should do the turn at a height such that they can get themselves out of trouble. The device is really an indicator of dynamic pressure (that is, $\frac{1}{2}\rho V^2$) and so indicates the straight stall at any altitude or temperature. (Straight stalling occurs at the same mark on the A.S.I. independent of these two variables, as every pilot knows.)

Supplementing the A.S.I.

The device seems to have a field of usefulness. On first thoughts, one would think that the modern airliner and its highly trained pilot were not in need of it. But "Indicator," in the issue of January 18, pointed out that aircraft with high wing loadings have very little "feel" and require "an almost hundred per cent. faith in such instruments as the airspeed indicator. You cannot *feel* the approaching stall," he says. He advocates two A.S.I.s and two pitot heads, having had his one let him down by registering some 40 m.p.h. too high. If a stall indicator were fitted, this could act as a reserve A.S.I., indicating, as it does, the critical value of flying speed. The case of a Lockheed 14 crash in Australia which took four lives because it was pulled off the ground too early in the take-off run springs to mind as another unfortunate occurrence which could have been prevented by a stall indicator.

It is not thought that student pilots learning to fly should have a stall indicator—they should be taught to "feel" their aeroplane. But when that student pilot goes off for his solo practices, after having three or four solo hours, no doubt his instructor might have fewer grey hairs if he knew a light was going to flash in the pupil's face should he get down near the danger point.

It has been argued as to whether a light or a hooter is the best warning. Mr. Waller prefers the light. As he says, the device starts acting just before touching down in a landing and continues till the run has slowed to about 20 m.p.h. It would not be steadying to a pupil's nerves to have a hooter start just as he was breaking the glide and making those delicate backward movements of the control column which hold her off until she is ready to sit. The designer also says it has been suggested to him that his device should pour out a whisky-and-soda to fortify the pilot for the approaching stall, but he feels that this might tend to popularise stalling practice too much.

The device has been tested by the Civil Aviation Department of Australia, and it is believed that their pilots and engineers are favourably impressed by it. No official pronouncement has yet been made.

FLIGHT

AIRCRAFT CONSTRUCTION NUMBER

Thursday, FEB. 8th, 1940.

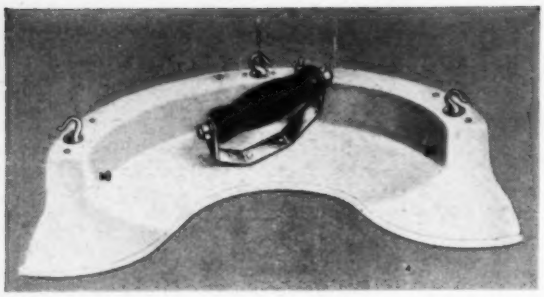
NEXT week's issue of "Flight" will be a special number mainly devoted to a survey of structural progress in the field of aircraft design, and a discussion of future possibilities. The development of airscrews, undercarriages and other components will also be embraced.

A review of present-day tendencies in aero-engine design will be a feature.

ORDER TO-DAY, THIS SPECIALLY ENLARGED ISSUE OF WIDE INTEREST.

Out Thursday next, Feb. 8th ..... Sixpence as usual.

THE INDUSTRY



The G.E.C. reflector concentrates light on to the job.

Shadow-free Lighting

FOR the illumination of drawing boards, fine bench work and other purposes a major requirement is a concentration of light, free from hand shadows and, in the interests of economy, from a lamp of relatively low candle power. G.E.C. have designed an entirely new fitting to meet these requirements.

The reflector, of anodised aluminium, is semi-circular and fitted with holders to take a standard 6¼in. radius, 60 watt, half-circle Osram architectural lamp of 30 mm. diameter. The fitting can be provided with fixing points for mounting on an adjustable wall-bracket or a counterweight suspension to give downward illumination. It is also available with a handle for use as a portable hand lamp. Further particulars are to be had from The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.

Hawker Siddeley

REVIEWING the past year's trading at the fourth annual general meeting of the Hawker Siddeley Aircraft Co., Ltd., held in London on January 24, Mr. T. O. M. Sopwith, C.B.E., F.R.Ae.S., remarked that the company's products figured largely in the extensive work being undertaken by the fighter, bomber and coastal patrol services. He also emphasised the fact that whereas practically the whole of the production effort of the Hawker Siddeley concern was naturally being directed to supplying the fighting services, it was still possible to maintain some export trade; indeed export trade for the year under review had contributed appreciably to the turnover.

Regarding the future, with all its unknown factors, Mr. Sopwith assured his listeners that this vast organisation, this vital link with the armed forces, is in a strong position and that the research and development programme is being carried on concurrently with production of both national and civil products.

After commenting on the excellent work of the operating company executives and complimenting Mr. F. S. Spriggs, the managing director, on his election as President of the Society of British Aircraft Constructors, Mr. Sopwith concluded with the remark that the Hawker Siddeley combine, covering as it does the manufacture of aircraft, aero engines, motor cars and accessories for the Services, and with commercial activities and a virile export market, constitutes one of the largest industrial undertakings of its type.

The balance sheet showed an immensely strong foundation on which the company rests despite the enormous provision required these days for taxation account. A final dividend of 17½ per cent., less tax, was declared, bringing the year's total up to 32½ per cent., less tax, and the carry forward for the next period increased from £108,190 to £221,012.

The story of Hawker Siddeley expansion would certainly make good reading. We hope it will be told when the piping days of peace are again with us.

Williamson Annual Dinner

THE annual dinner of the Williamson Manufacturing Co., Ltd., makers of the well-known "Eagle" aircraft cameras, was held on Saturday night, January 20, at the Grand Central Hotel, Marylebone Road, N.W.1. Now that the firm has established a second factory, the occasion served as a reunion for all members of the firm and of the associated company, the Willesden Engineering Co., Ltd.

Mr. Colin M. Williamson, C.B.E., F.R.P.S., the chairman, was accompanied by Mrs. Williamson. Others at the long table were Mr. and Mrs. S. Williamson, Wing Cdr. F. C. V. Laws, O.B.E., F.R.P.S., Major Kingsley, M.C., Mrs. Browne, Mr. and Mrs. T. S. Spurling, Mr. and Mrs. Rex Thomas, Misses Ainsworth, Edwards and Williamson, and Messrs. Sinclair, Ainsworth, S. and O. Edwards, Battersby, Chamberlain and Odle.

In replying to the toast of the Company, which Mr. Bright proposed, Mr. Colin Williamson said that the development of the new factory would enable those of the staff who had moved out there to enjoy better living conditions, including their own sports ground. Apparently the new factory was so clean that one man had found it impossible to stay!

In concluding; Mr. Williamson gave timely advice to the staff to save in such times of abundant work as the present. The directors had under careful consideration the question of the company's activities when the war was over.

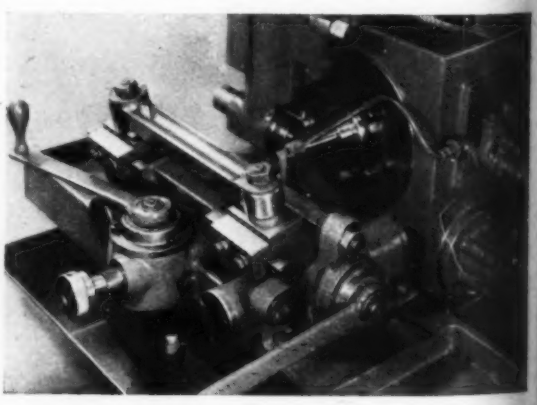
Mr. Stuart Williamson proposed the toast of the Guests, and referred to his recent departure to the new factory where he had been greatly assisted by the collaboration of Mr. Bright. Mrs. C. Pilbeam replied very nicely on behalf of the guests, and shortly after dancing commenced. Over 350 were present, and Mr. Pilbeam mastered the ceremonies so well—aided by the most rakish paper hats—that the happy evening ended all too quickly.

Automatic Grinder

BUSY introducing specialised machine tools to this side of the Atlantic are the Broadway Engineering Co., Ltd., Carlisle Rd., London, N.W.9, who have been appointed sole European agents for the American firm, Le Maire Tool and Manufacturing Company.

Particulars are available of a new automatic grinder for connecting-rod channels. It comprises a saddle and table actuated hydraulically and controlled by positive stops to give the required forward and return straight movements and co-ordinated, through an hydraulic circuit, with a high-speed grinding wheel head and carrier, capable of making a true radius at each end of the stroke. Combined with this is an automatic grinding dressing device, which will redress the wheel to form.

The grinding wheel spindle runs at 18,000 r.p.m. for a 11in. diameter wheel. The actuating means of the machine includes a 2 h.p. 3,400 r.p.m. motor; a 1½ h.p. motor connecting to a Vickers pump unit and a 1/40 h.p. motor operating the wheel dresser.



The Le Maire automatic grinder at work on an aero engine connecting rod.

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